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ORIGINAL ARTICLES.

I.—Restoration of *Stylonurus Lacoanus*, a Giant Arthropod from the Upper Devonian of the United States.[1]

By Professor Charles E. Beecher, Ph.D., of Yale University, New Haven, U.S.A.

(PLATE XVIII.)

IN the animal kingdom the attribute of bigness has come to be regarded as one of the prerogatives of the vertebrates. On this account, invertebrates seldom receive credit for having a size of more than a fraction of a cubit, and are looked upon as objects to be held in the hand or viewed under a lens. As a matter of common experience, and probably also of congratulation, large invertebrates *are* rare, and some whole classes cannot furnish a single individual measuring more than a few inches in greatest diameter.

In a list of arthropod giants the subject of the present note must be included, and will take equal rank with the Giant Spider-Crab of Japan (*Macrocheira Kaempferi*) and the great 'Seraphim' of the Scotch quarrymen (*Pterygotus anglicus*). The former can safely claim to be the largest representative of the Brachyurans that has ever existed, and to the latter may be accorded the same distinction among the Merostomes.

The living species of the Merostomata comprise only the American and Moluccan Horse-shoe Crabs, *Limulus polyphemus* and *L. moluccanus*. The latter sometimes attains a length of three feet and measures eighteen inches across the carapace. To find other species in this order worthy of comparison with the huge Brachyuran of Japan it is necessary to go back to the Palæozoic forms, and among these the larger species of *Pterygotus* and the *Stylonurus* here noticed fill all the requirements. It should be borne in mind, however, that these statements are based upon comparative lengths and breadths. If bulk alone were considered, the common lobster (*Homarus americanus* and *H. vulgaris*) should be mentioned, though in length and extent of limbs it would be considerably smaller.

Concerning the size of the Scotch 'Seraphim,' Dr. H. Woodward[2] states that "From our present knowledge of the almost perfect

[1] Reprinted from the American Journal of Science, vol. x, August, 1900, pp. 145–150.

[2] H. Woodward, "A Monograph of the British Fossil Crustacean belonging to the Order Merostomata," pt. i, 1866; pt. iv, 1872, pp. 1–264, pls. i–xxxvi: Palæontographical Society, vol. xix.

remains of *Pterygotus anglicus*, and on the evidence of the numerous detached portions of this extinct genus, we are justified in concluding that it attained a length of six feet and a breadth of nearly two feet at the widest part of its body." This huge Merostome has been found in the Lower Old Red Sandstone of Scotland, at a horizon nearly equivalent to the one furnishing the remains of *Stylonurus* in America. Thus what seem to be the two largest species of this class were contemporaries, though not associates.

Historical.

The first specimen found in America that can be referred to the genus *Stylonurus* was collected by the writer about 1870, and loaned to Professor James Hall. It remained in his hands unnoticed until 1884, when he described it as *Eurypterus Beecheri*.[1] The specimen preserves the abdomen and portions of two of the large posterior limbs. No species of *Eurypterus* known possessed such greatly elongated limb joints, and there seems to be no good reason for not referring it to *Stylonurus*, in which there is a normal character. The specimen of *Stylonurus Beecheri* is uncompressed, and apparently retains the proportions of form and convexity as in life. On this account it was of considerable importance in the restoration of the larger species.

In 1882 Hall was furnished with a plaster cast of the carapace of a large arthropod by Dr. Cook, then State Geologist of New Jersey. The original specimen was from the Catskill group at Andes, Delaware County, New York, and had been sent to the museum at Rutgers College, New Brunswick, New Jersey. Professor D. S. Martin[2] made the first reference to this species in some remarks on "A New Eurypterid from the Catskill Group," before the New York Academy of Sciences, October 16, 1882, an abstract of this note appearing in the transactions of the same society some time after June, 1883. In this abstract the species is neither described nor figured, and Hall is not mentioned in any connection. Martin states that he saw the specimen (= cast sent to Hall) in the State Museum at Albany, and it bore the name *Stylomurus excelsior* (evidently a misprint for *Stylonurus*).

The next reference to this form in point of time and the first publication of a generic and specific name, accompanied with a description and accurate illustration, was given by E. W. Claypole,[3] in a paper read before the American Philosophical Society, Sept. 21, 1883, under the title "Note on a large Crustacean from the Catskill Group of Pennsylvania." It is stated on the signature containing this paper that it was printed Nov. 2, 1883. Claypole's description

[1] J. Hall, "Note on the Eurypteridæ of the Devonian and Carboniferous Formations of Pennsylvania": Second Geol. Surv. Penn., PPP, 1884.

[2] D. S. Martin, "A New Eurypterid from the Catskill Group": Trans. N.Y. Acad. Sci., vol. xi (1882–1883).

[3] E. W. Claypole, "Note on a large Crustacean from the Catskill Group of Pennsylvania": Proc. Amer. Phil. Soc., vol. xxi, April, 1883, to January, 1884.

was based upon a second specimen found in Wyoming County, Pennsylvania, which preserves about three-fourths of the cephalothorax, and belonged to the collection of R. D. Lacoe, of Pittston. This was given the name *Dolichocephala Lacoana*, and rightly classified with the Merostomata. It therefore appears that, up to this time, the name *Stylonurus excelsior* was simply *nomen nudum*, and as such cannot be recognized as valid.

In 1884 Hall[1] published his description and figure of the New York specimen in the thirty-sixth Annual Report of the New York State Museum, in a paper entitled "Description of a New Species of *Stylonurus* from the Catskill Group."[2] It is here that the New York specimen was first figured and a description given, and the date of publication of this paper is the one to be considered in deciding the claims of *Stylonurus excelsior* as Hall's species.

At the Philadelphia meeting of the American Association for the Advancement of Science, September, 1884 (Proc. A. A. A. S., vol. xxxiii, published 1885), Hall[3] presented a note on *Stylonurus excelsior*, merely referring to its occurrence, and citing Martin's abstract with page and month of publication. This citation is repeated by Hall in each of his notices of this species, for only by thus establishing the species could he have any claim to priority. As already mentioned, Martin's paper does not attempt any description of this form, and Hall is not mentioned. Hall further says: "The carapace is described and figured in the 36th Report of the N.Y. State Museum of Natural History," without reference to plate, page, or year, and it is therefore quite possible that this description was not published until after the meeting of the Association. In any case, it appeared some months later than Claypole's paper, and the name *Dolichocephala Lacoana* has priority over *Stylonurus excelsior*, and must be recognized.

Claypole failed to point out the affinities of this form with *Stylonurus*, and proposed a new generic term for his species. Although there are differences that may prove of generic value when more complete specimens of the American species have been studied, yet at the present time there seem to be no strong reasons why the specimen in question should not be considered as belonging to *Stylonurus*, and it is upon this ground that the present restoration is attempted.

Material available for a Restoration.

Restorations of extinct organisms are largely exhibits of mental architecture, based upon the personal interpretation of a certain

[1] J. Hall, "Description of a New Species of *Stylonurus* from the Catskill Group": Thirty-sixth Ann. Rep. N.Y. State Mus. Nat. Hist., 1884.

[2] J. Hall & J. M. Clarke, "Trilobites and other Crustacea of the Oriskany, Upper Helderberg, Hamilton, Portage, Chemung, and Catskill Groups": Geol. Surv. of the State of New York, Palæontology, vol. vii (1888).

[3] J. Hall, "Note on the Eurypteridæ of the Devonian and Carboniferous Formations of Pennsylvania, with a supplementary note on *Stylonurus excelsior*": Proc. Am. Assoc. Adv. Sci., vol. xxxiii (1885), Philadelphia Meeting (held September, 1884).

number of real things. Some statement, therefore, should be given of the character and amount of the material that has been collated to furnish a restoration of *Stylonurus Lacoanus*.

(1) The specimen of the cephalothorax described by Hall shows the complete outline and upper surface of this part, and a cast from the original was taken to represent this portion in the restoration. (2) The type of *S. Lacoanus*, Claypole, includes a large part of the cephalothorax of an individual nearly the same in size as the preceding. (3) Dr. J. M. Clarke discovered that this specimen also preserved considerable evidence as to the nature of the appendages, and he succeeded in developing what appear to be the chelate antennæ, the first pair of gnathopods, and the mandibular bases of at least three others. (4) The length and number of joints in the limbs are taken from the English species *S. Logani* and *S. Powriei*, of which quite complete, though smaller, individuals have been described by Woodward.[1] (5) The outline and proportions of the abdomen follow closely those of the English forms and of *S. Beecheri*, the latter giving the natural convexity. (6) A portion of a large abdominal segment found by the writer in the Chemung group at Warren, Pennsylvania, and apparently belonging to a nearly related species, has an ornamentation closely approaching that on the cephalothorax of the type, and was used to elaborate the sculpture over the abdomen of the restoration. (7) The form and character of the telson spine correspond to *S. Logani* and also to some large fragments found by F. A. Randall at Warren and Ackley, Pennsylvania, in the Chemung group, and probably belonging with the abdominal somite already mentioned.

With the data furnished by the foregoing material, the restoration was undertaken. The first model in relief was constructed in clay, and from it a plaster mould was taken. A number of casts have been made since, and a photograph of one of them is represented in the accompanying plate (Plate XVIII).

In this connection, it may be suggested that the type-specimen of *Stylonurus* (?) (*Echinocaris* ?) *Wrightianus* (Dawson, sp.) represents two proximal joints of one of the large crawling feet of a form related to *Stylonurus*, and not two somites of the abdomen as indicated by Hall.[2] Any reference is at present somewhat uncertain, owing to lack of positive knowledge, and the fact that the specimen in question was first described as a plant (*Equisetides*[3]), then referred to the Phyllocarida (*Echinocaris*[4]), and lastly appeared as a possible Merostome, shows how this form may be interpreted by different observers. No one can doubt its arthropod nature, on account of

[1] Loc. cit.

[2] J. Hall: Note to explanation of plate xv of paper on Geology of Yates County, N.Y., by B. H. Wright: Thirty-fifth Ann. Rep. N.Y. State Mus. Nat. Hist., published 1884.

[3] J. W. Dawson, "Notes on New Erian (Devonian) Plants": Quart. Journ. Geol. Soc. London, vol. xxxvii (1881).

[4] T. R. Jones & H. Woodward, "Notes on Phyllopodiform Crustaceans, referable to the Genus *Echinocaris*, from the Palæozoic Rocks": Geol. Mag., n.s., Dec. III, Vol. I, September, 1884.

the characteristic surface markings. Its elliptical or ovoid section without any flattening of the epimera, the very considerable overlapping of the joints, and the configuration of the suture, are more strongly indicative of the nature and requirements of a limb than of abdominal segments.

The Relief Model.

In this restoration the animal is represented as lying on a slab, with the entire dorsal surface exposed. The cephalothorax has an axial length of 25 cm. and a width of 22 cm.

The chelate antennæ were doubtless carried in a folded position, as in most related genera, and seldom were visible from the dorsal side. They are, therefore, not shown. The three pairs of short gnathopods, serving partly as swimming organs, are seen extending outward from the antero-lateral margins of the cephalothorax. Several of their distal joints are each provided with a pair of flat, ridged, spinous processes, and a similar spine at the termination of the limb.

The two pairs of great crawling feet extend outward and backward from the postero-lateral margins of the cephalothorax. The anterior pair expose 109 cm. of length, and the posteror pair about 108 cm. The elements of the limbs are represented as grooved, as this character seems necessary to give the needed strength to long slender joints, and also because a similar conformation is present in *S. Beecheri*.

The abdomen measures 30 cm. in greatest width at the fifth segment, and 66 cm. in length exclusive of the telson. The posterior abdominal segments are represented without detachable epimera, as this feature is not as yet known to be constant for the genus, although present in some species.

The telson spine agrees proportionally in length with the same member in *S. Logani* and *S. Powriei* as described by Woodward,[1] and was given a slight upward curvature as in *Limulus*. It measures 54 cm. in length and 7·5 cm. across at the proximal end.

Altogether the animal as restored has a length of nearly five feet (147 cm.), and with the legs extended it would measure about eight feet (242 cm.) across.

It is not intended to claim any high degree of accuracy for this restoration, but merely to represent in some graphic form an animal approximating in size and character an individual of the species *Stylonurus Lacoanus*. Its size alone was the chief incentive for attempting a reconstruction, and some sacrifice of exact detail may well be allowed in order to make any presentation of this magnificent arthropod.

[1] Loc. cit.

II.—On *Hyperodapedon Gordoni*.

By Prof. Rudolf Burckhardt, Ph.D., of the University of Basel, Switzerland.

(PLATE XIX.)

THE fossil to be discussed in the present memoir is the specimen which formed part of the classical material used in the discussion which was carried on amongst British geologists during the second half of the present century. So important a controversy could hardly be restricted to the geographical limits of England alone.

In the question of the age of the Elgin Sandstones, considered by Sir Roderick Murchison to be Palæozoic, it was Huxley who pronounced upon it finally,[1] after the discovery of and in his subsequent description of *Hyperodapedon*.[2] His decision in this geological controversy was given on the evidence derived from a far less perfect specimen than the one represented on Plate XIX. It also supplied Huxley with an opportunity for speculations concerning the affinities of the animal with *Sphenodon*, from New Zealand, a reptile which Dr. Günther had just then presented in all its scientific aspects. On the other hand, these speculations carried Huxley far out upon an ocean of geographical as well as of geological hypotheses.

A second specimen, which was obtained much later, afforded Huxley a welcome opportunity to supplement his earlier description of *Hyperodapedon* as regards its most prominent differences from *Sphenodon*, the details of its skull and diverse other anatomical points of no less importance. The motives which have impelled me to undertake a re-examination of the subject may appear scarcely obvious and require some explanation.

During the perusal of the literature relating to the Rhynchocephalians I was confronted very frequently by differences, essentially anatomical in character, tending to a separation of the Rhynchosauridæ from the Sphenodontidæ. In the first place I was unable to assign any valid reason for a closer relationship existing between them, whilst, on the other hand, the Rhynchosaurians appeared to me to possess characters important enough to justify the conclusion of a complete connection between Chelonians and the remaining Theromorphæ. Further investigation into the literature of the subject and the material available disclosed so many enigmas, that I at last decided to visit London and obtain permission to study the original specimens in the Natural History Section of the British Museum.

According to Huxley's illustration of the skull I expected the original object to be only a cast of the coarsest description, but in this I was speedily undeceived after a personal inspection, and to my great delight I perceived that I had one of the choicest of originals before me which grace the grand collection of fossil reptiles in the British Museum.

[1] Quart. Journ. Geol. Soc., 1859, vol. xv, p. 460.
[2] Op. cit., 1887, vol. xliii, pp. 675–693, pls. xxvi–xxvii.

R. Burckhardt del.

Hyperodapedon Gordoni, Huxley; ventral aspect. One-fifth nat. size. The right anterior extremity being absent, the left, which is preserved in the counterpart, has been added to this plate. Original in the British Museum (Natural History).

I very much doubt whether it would have been possible to comply with my request in a more generous manner than was done by the respected Keeper of the Geological Department of the British Museum, Dr. Henry Woodward, F.R.S., to whom, as to Drs. A. Smith Woodward and C. W. Andrews, of the same Department, and to Mr. G. A. Boulenger, F.R.S., of the Zoological Department, it gives me the utmost pleasure to tender my heartiest thanks for their ever ready assistance and advice.

As might be supposed, a re-preparation of such a valuable original object was totally out of the question, though I have no doubt that, if performed with the necessary care, many minute anatomical details would be brought to light.

In my drawings, therefore, I filled in with black all those parts which were left untouched by the chisel like the rest of the matrix of the stone. The artist employed on Huxley's sketch has failed to convey any precise information as to which is stone and which is bone, and has produced as structures shapes which only existed in the imagination of the mason as having belonged to the skull itself.

In my drawing of the skeleton *in sitû* I have carefully confined myself to a representation of the exposed portions of the actual bones, thus avoiding the risk of reproducing anything foreign to it on the face of the stone. This ought to remove all doubts that may exist as regards serious mistakes, especially where parts are concerned which are of importance.

An ordinary photographic reproduction of the fossil would not have been a great gain for the student, as the observer would have been under the necessity of making out the details of the actual fossil for himself, not to mention the disturbing effect of countless ochre spots which are distributed all over the surface of the matrix.

Plate XIX is a photographic reproduction of the entire skeleton, reduced to $\frac{1}{5}$ of its natural size, from the original in the British Museum. With the exception of the distal part of the left limb, which is better preserved on the counterpart, no other portions of the skeleton are seen on that slab. I therefore have transferred it from that side on to the plate also, as otherwise I should have had to dispense with its reproduction altogether. This plan, moreover, had the advantage of completing the representation of the skeleton in one view.

It should also be pointed out here that in consequence of having had recourse to photographs, the lower part of the leg, and the foot, are diminished in size by $\frac{1}{5}$ on account of the focal distance from the main portions of the skeleton, which further tends to increase the disparity already existing between the two extremities.

For a general description of the skeleton I would refer the reader to Huxley's memoir (see Quart. Journ. Geol. Soc., 1887, vol. xliii, pp. 675–693, pls. xxvi and xxvii, and 8 text-figures). To this I am obliged to add merely that I feel by no means sure of his statement that the præsacral portion of the vertebral column terminates with the 23rd vertebra, or even with the 22nd; but of this I feel confident, that there are not twenty-four vertebræ, as

asserted by that author, who also gives the number in *Sphenodon* as twenty-five. Apart from this, the entire pelvic region appears to me to be scarcely well enough preserved to positively assign to it two sacral vertebræ.

Whether the above inference was possible from the first specimen at Huxley's disposal, or not, I do not know, as he does not express himself on this point in his first description of this portion of the skeleton of *Hyperodapedon* in Quart. Journ. Geol. Soc., 1859, vol. xv, p. 460. From analogy in *Sphenodon*, Huxley has estimated the length of its tail to be about 110 mm., though no reliable data are obtainable from the fossil itself. I would also wish to remark here that the sacral vertebræ are only $\frac{3}{4}$ the length of the hindmost thoracic vertebræ, and from this fact alone it may be seen that Huxley's computation of the length of the tail appears to be an over-estimate.

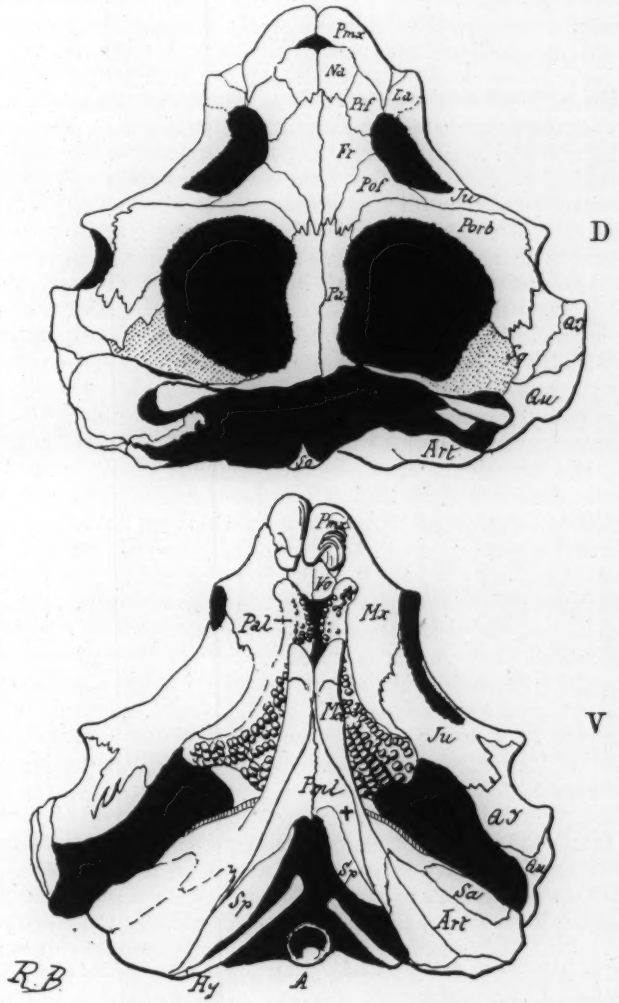
Of the remaining portions, the shoulder-girdle alone calls for some remarks here. The position assigned by Huxley to the interclavicle is the correct one, but there is an error as regards the spatulate shape of its posterior margin which requires modification. Posteriorly the episternum terminates in quill-like processes, separated from each other by a deep incision, as is the case in a great number of Lacertilians. Besides this, but noticeable only on the right side, its clavicular margin bifurcates into two pointed projections, as in *Rhynchosaurus*. The bone which Huxley designated the coracoid is really composed of two parts, the coracoid and the præcoracoid.

The most important part of this fossil is its skull, and it is here principally that I dissent from Huxley's interpretations. I therefore felt compelled to refigure and re-describe it, a proceeding to which I shall add also those inferences which I have been enabled to draw from other fragmentary specimens deposited in the British Museum (Natural History).

The general topography of the skull has been admirably rendered by Huxley. As a further adjunct to his admission that, although *Hyperodapedon* was essentially terrestrial in habits, yet it had at the same time a predilection for leading an aquatic life, may be mentioned the anomalous position of the orbits, which are so strangely directed upward and situated forward as to deserve to be specially pointed out here.

The first attempt towards a more precise knowledge of the component parts of the skull than that by Huxley was by Dr. A. Smith Woodward, who partly traced the boundaries of the nasals, the postorbitals, the jugular and other bones. It has been a great satisfaction to me, as the result of my endeavours to make out the sutures, to find myself so entirely in accord with Dr. Smith Woodward, without any deviations whatever, the more so as I did not consult his sketch at the time. Numerous fresh details having come to light, during a more protracted study of the fossil, a fresh illustration of the skull cannot be dispensed with under the circumstances. I have therefore executed the accompanying drawings from photographs taken by myself.

In these figures I have also blackened those parts of the matrix which have not yet been laid bare, in order to avoid any misconceptions arising from the supposed shape of the most important parts of the slab.



Outlines of the skull of *Hyperodapedon Gordoni*, dorsal (*D*) and ventral (*V*) aspects, from photographs and drawings by the author. One-half nat. size. *A.* atlas; *Art.* articular; *Fr.* frontal; *Hy.* hyoid; *Ju.* jugal; *La.* lachrymal; *Md.* mandibular; *Mx.* maxillary; *Na.* nasal; *Pa.* parietal; *Pal.* palatal; *Pmx.* premaxillary; *Porb.* postorbital; *Pof.* postfrontal; *Prf.* præfrontal; *Pspl.* præsplenial; *Qu.* quadratum; *QT.* quadratojugal; *Sa.* supra-angular; *So.* supraoccipital; *Sp.* splenial; *Vo.* vomer. The cross shows the centrum of crushing, which disordered the surrounding bones.

The general impression which these figures convey is that, even on a more complete development of the skull than has already been executed, the dorsal side, at any rate, would not present very massive proportions. Yet, the surfaces of the bones themselves are of a very hard and dense structure, and are possessed of ridges and protuberances which leave no doubt as to their homogeneity with the respective bones, even where their sutures are more indistinct. These anatomical characters are especially well defined on the maxillary and the jugular.

The sutures form slightly serpentine lines, except between the parietal and the præfrontal, where they are serrated. The præmaxillaries, which enclose the nasal cavity, as mentioned elsewhere, terminate caudally in blunted points, which are broken off, but the original form of which is preserved still as an imprint on the præfrontal. The margin of the nasal impinges somewhat on the median contours of the præmaxillaries, apparently to lend them additional strength, and to prevent their breaking out easily. Laterally they are held in position similarly, by a coarsely indented margin of the maxillary.

The limits of the lachrymals are more difficult of determination; firstly, because their ventral sides are embedded in the stone, and secondly, because their dorsal surfaces are damaged. Their existence, however, cannot well be doubted, if we may judge from analogy in *Rhynchosaurus*, where they are most clearly defined.

I fully concur with Dr. Smith Woodward in his determination of the middle of the cranium, although the lateral margin of the præfrontal appears to me to be clearly enough circumscribed.

Features actually new as to their interpretation appear again only behind the orbit, where the postorbital is conspicuous both by its shape, its position, and by being entirely excluded from participation in the orbital foramen. It forms the whole of the anterior portion, and part of the lateral contour of the temporal fossa. Its posterior end is unfortunately broken off, but no doubt can be entertained as regards its original shape, from the evidence supplied by the surface of its underlying squamosal, on which the outlines of its margin can be identified distinctly.

The squamosal itself is in a very imperfect state of preservation. It is connected with the præorbital, and participates in the formation of the supratemporal foramen; a ramus of the quadrato-jugular ascends to the latter, on the outer side of the squamosal. The squamosal is represented in its greater part only by the mould which it has left in the stone. It is quite probable that a posterior temporal fossa was formed by the squamosal and a branch of the quadrate bone, but on this point the information to be obtained from literature is of too vague a nature to allow our arriving at any definite conclusions thereon.

The quadrate itself is a broadish, disk-like bone, deepened in the centre. Its complete immobility can be ascertained from the fact that it is joined to the squamosal and the quadrato-jugular by suture. It could not have participated in the formation of the lateral temporal foramen; that office was reserved to the quadrato-

jugular lying in front of it, which in its turn is connected again with the peculiarly shaped jugular. This latter bone borders the anterior portion of the temporal fossa, and forms, as far at least as it is exposed, the base of its posterior limits. Two strongly developed longitudinal ridges stretched across it, of which the lateral one, which is the shorter of the two, is projected towards the quadrato-jugular by means of rough spines. Its normal situation on the skull is preserved only on the left side, from which it has been figured. Leaning against it and to the front of it, is the maxillary, which I found to deviate considerably from previous descriptions. The maxillary is edentulous, and separated from the exclusively dentigerous palate-bone by a distinct suture, which is not only the case in this skull, but I have been enabled to verify it in another separate fragmentary bone in excellent preservation. Only a narrow branch of it separates the anterior margin of the palatine from the præmaxillaries, without any indication of a ridge on the inner nasal foramen. Dorsad it interlocks by means of a small angle only with the præmaxillary and the lachrymal bone.

Not more than three bones are discernible in the roof of the mouth.

The vomers join each other along the median line, but both their anterior as well as their posterior margins are covered in this case by matrix. On the right side they are in their natural relationship to the palatal bone, the maxillary, and the præmaxillary. Not so on the left, where the original contact has been disturbed by crushing in such a manner that Huxley was tempted to suggest the existence of inner nares in this particular place. For my own part I find it most difficult to adopt this view, as I opine that they are more likely to be found in the gap between the posterior margin of the palate-bones, if the lower jaw could be separated from the rest of the skull.

The palatine bones themselves are curved, thinnish plates, with their anterior margins rounded off. Their posterior margins articulate with the subcircular pterygoids, of which only the right one is completely preserved.

The mandibular ramus is composed of several separate bones similar to many other reptiles. They do not articulate on their margins by means of jointed sutures, but overlap each other like flakes, and therefore render a clear and precise description somewhat difficult. No doubt can prevail about the mandibulars. Their curved sulci, placed at a short distance from the apices, appear to me to be a good indication of the limits to which the horny sheaths come in close contact with the bone, which, however, is not so far as might have been assumed at first sight. Their posterior margin is very indistinct, through injury to the outer crust of the bone, and can therefore only be guessed. The mandibulary at this place is in contact with two bones, one of which I take to be the articular, from the fact that it articulates with the quadrate bone, whilst the other, the supra-angular, though represented only by its impression, nevertheless agrees with Owen's statement in regard to the corresponding bone in *Rhynchosaurus*. The ventral margin of the

inframaxillaries is formed by the splenials. It is these latter which contribute principally to the formation of the symphysis, at least externally. Indeed, they are so strongly united as to form a process on their posterior margin.

The angulary is not preserved here, but it is present in *Hyperodapedon minor*,[1] in which a portion of the coronoid bone seems to be also partly preserved. In the latter species the position of the opercular can be made out with tolerable clearness. It reaches to about the middle of the inferior ridge of the lower jaw.

The remains of the hyoidal bones have already been referred to by Huxley.

(*To be continued.*)

III.—A Summary of our Present Knowledge of Extinct Primates from Madagascar.

By C. I. Forsyth Major, M.D., F.Z.S.

ALTHOUGH the present summary covers the same ground reviewed only a few months ago by the junior bearer of the name which will always be gratefully and prominently remembered in connection with the scientific conquest of Madagascar,[2] the following lines will show that, short as the interval has been, the new additions are not unimportant.

If it might be regretted that many of the new facts are being served out, as it were, by driblets, this in most cases is scarcely to be avoided, as many of the specimens on which the evidence rests are very fragmentary, and besides dispersed in various Museums. In the case of more complete materials, the preparation for publication requires, for obvious reasons, a longer time, so that the provisional sifting of the material may not be out of place, were it only to keep as much as possible within reasonable limits the often unavoidable increase of synonymy.

As far as the remains recorded by M. G. Grandidier[2] are concerned, mention is made in the present notice only of those about which I have something new to say.

I. MEGALADAPIS.

At the December meeting of the Zoological Society[3] I briefly noticed under the name of *Megaladapis insignis* a new species of this genus, based on fragments of the upper and lower jaw, which I have fully described in another place.[4] The Geological Department of the British Museum has since acquired the anterior portion of another skull of the same species, probably ♀, which shows that in the adult condition, at any rate, this animal was devoid of upper

[1] I wish to give this name to a fragment mentioned by Huxley, Q.J.G.S., 1859, p. 146, and specifically different from *H. Gordoni*.

[2] Guillaume Grandidier, "Sur les Lémuriens subfossiles de Madagascar": C. R. Ac. Sci. Paris, 28 Mai, 1900.

[3] Proc. Zool. Soc. London, 1899, p. 988.

[4] "Extinct Mammalia from Madagascar. I. *Megaladapis insignis*, sp.n.": Phil. Trans. Roy. Soc. London, vol. cxciii (1900), p. 47.

incisors. This is another agreement with the recent Malagasy genus *Lepidolemur*, attested also by the similarity in the pattern of the molars. The strongly curved nasals of this *Megaladapis* protrude forward more than in any other Lemuroid.

Dr. v. Lorenz has of late[1] published under the name of *Megaladapis brachycephalus*, sp.n., the upper and the side view of the skull of a *Megaladapis* taken from photographs which had been communicated to various museums and zoologists by the collector, Sikora, who had discovered the remains in a cave near Fort Dauphin on the south-east coast. This skull is, in my opinion, of the same species as the above-mentioned remains in the British Museum, which are from the same locality. In the same paper[2] Dr. Lorenz publishes another photograph, representing the side view of a Lemurine skull from the same cave near Fort Dauphin; the figure is briefly described, and named "*Mesoadapis destructus*, gen. nov. spec. nov." The original of the photograph had been previously acquired by the British Museum,[3] and will be described in detail shortly. It belongs to a young individual of *Megaladapis insignis*: the three cheek-teeth visible are the deciduous molars; the caniniform tooth, exhibited in profile in the photograph, is the anterior protruding portion of the permanent canine. This skull confirms the opinion formerly expressed by me, viz., that young specimens of *Megaladapis* would show a much closer approach to the ordinary Lemurine type than the adult in the conformation of the brain cavity and its walls.[4] From what has been stated above, the synonymy of the species is as follows:—

MEGALADAPIS INSIGNIS, Maj.[5]

Syn. *Megaladapis brachycephalus*, Lor.[6]
Palæolemur destructus, Lor.[7]
Mesoadapis destructus, Lor.[8]

From the well-known locality Ambolisatra, on the south-west coast of Madagascar, G. Grandidier has described two femora, the larger of which he considers as belonging to *Megaladapis madagascariensis*, whilst the smaller is provisionally called *Megaladapis* (?) *Filholi*.[9] Both the bones share the same general characters, viz., shortness and extreme antero-posterior flattening; but the differences, as has been pointed out by Mr. Grandidier, are sufficient to warrant their being referable to two different although closely allied genera.

[1] Ludwig Ritt. Lorenz v. Liburnau, "Über einige Reste ausgestorbener Primaten von Madagaskar": Denkschr. Akad. Wiss. Wien., lxx (1900), p. 8, pl. ii.
[2] Op. cit., p. 10, pl. iii, fig. 3.
[3] Dr. v. Lorenz, when writing his paper, was not aware of this circumstance.
[4] Phil. Trans. Roy. Soc. London, B, vol. clxxxv (1894), p. 27; Proc. Roy. Soc. London, vol. lxii (1897), p. 49.
[5] Proc. Zool. Soc. London, December 19, 1899, p. 989.
[6] Op. cit., 1900, p. 8, pl. ii.
[7] Anzeiger Akad. Wiss. Wien., 1900, No. 1, p. 8 (*teste* Lorenz).
[8] Denkschr. Akad. Wiss. Wien., lxx (1900), p. 10, pl. iii, fig. 1.
[9] Bull. Mus. d'hist. nat. Paris, 1899, No. 6, pp. 272–275.

The smaller of the two bones does not seem to me to be out of proportion with the skull of *Megaladapis madagascariensis*; if this supposition is right, the larger femur may prove to belong to *Peloriadapis*, a new genus allied to *Megaladapis*, based by G. Grandidier on some teeth from the same locality.[1]

A decided approach towards the Nycticebinæ, especially the West African *Perodicticus* and *Arctocebus*, is the flattening of the shaft of both these femora, and the slight curvature with the concavity forwards, together with the large head and the very large plate-like 'lesser' trochanter of the smaller of the two, a specimen of which, from the same locality, is in the British Museum. These resemblances may or may not be an indication of closer relationship; on the other hand, the locomotion can scarcely have been the same in the two groups. If the sluggish Nycticebinæ are to some extent comparable in their habits and locomotion with the Bradypodidæ, the clumsy *Megaladapis* can scarcely be supposed to have been climbers at all. The remarkable shortness and flattening of the *Megaladapis* femur calls to mind the same bone of aquatic Mammalia; the elevated position of its orbit would point in the same direction.

As to the affinities of *Megaladapis* with other Lemuroids, I now hold that its specializations are not a sufficient reason for its being removed into a separate family. There are in the first place undoubted affinities in the pattern of the cheek-teeth with *Lepidolemur* and also with the Indrisinæ. Relying chiefly on the vertebral column, Mivart long ago submitted that *Lepidolemur* "seems to be that genus of the Lemurinæ which most approximates to the Indrisinæ."[2] In this I fully concur, as the characters of the molars and the leg-bones point in the same direction. On the other hand, Winge has insisted on the relationship of *Chiromys* with the Indrisinæ, and in my opinion he is, as usual, right here also. It will thus be possible to show that these four groups, at first sight so very different from each other, because each of them is specialized in a different direction, are closely related to each other, and presumably had a common origin. There are, besides, reasons for the assumption—the molar pattern for one—that they were derived from a common stem with the Cebidæ. Whether this is the right view, the future will show.

II. PALÆOCHIROGALUS.

Another recent addition to our knowledge of extinct Malagasy Lemurids is equally due to M. G. Grandidier. He describes and figures two teeth, which "recall in their general form the two last upper molars of *Chirogalus*," and accordingly calls them *Palæochirogalus Jullyi* (nov. gen. et nov. sp.).[3] These teeth, from the marshes of Sirabé, belong, in my opinion, to an extinct form of the genus *Lemur*, the figure to the right representing the first or second left upper true molar, whilst the figure to the left appears to be the

[1] Bull. Mus. d'hist. nat. Paris, 1899, No. 6, p. 275; No. 7, p. 344.
[2] Proc. Zool. Soc. London, 1873, p. 490.
[3] Bull. Mus. d'hist. nat. Paris, 1899, No. 7, p. 345.

posterior upper deciduous molar. A peculiar feature of these teeth is the strong development of the antero-external cusp. Von Lorenz has figured, after photographs received from Sikora, the upper and side view of an imperfect skull of apparently the same species, from the cave of Andrahomana, near Fort Dauphin.[1]

III. NESOPITHECUS and allies.

Under various generic denominations, viz., *Lophiolemur*, Filh. (1895), *Nesopithecus*, Maj. (1896), *Globilemur*, Maj. (1897), *Bradylemur*, G. Grandid. (1899), *Protoindris*, Lor. (1900), a certain number of more or less fragmentary skulls and lower jaws of apparently very closely allied extinct Primates from Madagascar have been briefly noticed during the last few years.

It is quite possible that, when more completely known, these remains may in fact deserve to be classed in more than one genus; on the other hand, some of the specific names will be reduced to synonyms; for the present, or at least for the purpose of the present notice, this is unessential. Should they prove to belong to one genus, the name *Lophiolemur* would have the priority, or rather probably *Archæolemur*, a name based by Filhol on some leg-bones from Belo on the west coast;[2] the few characters given of the humerus of *Archæolemur* agree with those of two species of *Nesopithecus*. The primary question, however, refers to their relationship with other Primates.

The first noticed of all these remains is the cranial portion of a skull, which I described and figured in 1893,[3] approximating it to *Hapalolemur*; the name *Globilemur* assigned to it dates from 1897.[4] In the marshes of Sirabé (Central Madagascar) I subsequently found the anterior portion of a skull and other remains, which I shortly described under the name of *Nesopithecus Roberti*, establishing for them a separate family of Anthropoidea, "intermediate in some respects between the South American Cebidæ and the Old-World Cercopithecidæ, besides presenting characters of its own."[5]

Meanwhile Filhol had published the new genus *Lophiolemur* (*L. Edwardsi*), chiefly on two mandibular rami discovered long ago by M. A. Grandidier at Ambolisatra (south-west coast).[6] These rami, which I have been able to examine owing to the kindness of Professor Filhol, are undoubtedly closely related, if not generically identical, with *Nesopithecus*; it seemed to me that their molars were slightly more lophodont than in the latter genus. G. Grandidier, in his turn, has discovered at Belo an upper and a lower jaw, the characters of which justify in his opinion the creation of the new genus *Bradylemur* (*B. robustus*), related to *Lophiolemur* and to *Nesopithecus*.[7]

[1] Op. cit., p. 14.
[2] Bull. Mus. d'hist. nat. Paris, 1895, No. 1, p. 13.
[3] Proc. Zool. Soc. London, 1893, p. 532.
[4] Proc. Roy. Soc. London, vol. lxii (1897), p. 46.
[5] Geol. Mag., Dec. IV, Vol. III, October, 1896, p. 436.
[6] Loc. cit., p. 13.
[7] Bull. Mus. d'hist. nat. Paris, 1899, No. 7, pp. 346–348, with five text-figures.

A beautifully preserved skull in the British Museum, from a cave near Fort Dauphin (south-east coast), briefly described by me under the name of *Nesopithecus australis*,[1] showed first of all that *Globilemur* is a member of this group and probably not generically distinct from *Nesopithecus*,[2] and that *Nesopithecus* shared with the lemurs, especially those of Madagascar, a certain number of cranial characters. It also shows that I was mistaken in supposing that *Nesopithecus Roberti* had the orbits separated from the temporal fossæ by a bony wall; and although the absence of the latter is not, strictly speaking, a character which can find a place in the diagnosis of lemurs, as distinguished from the monkeys, it certainly is a more primitive feature than the presence of a bony septum. And so are the lemurine features of the *Nesopithecus* skull, viz., the conformation of the *basis cranii*, especially of the bulla tympanica, the character of the malar bone reaching the lachrymal, etc.

One lemurine feature of *Nesopithecus*, the position of the lower caniniform tooth, which does not bite in front of the upper, may be considered to be a transition between the condition exhibited by the New World monkeys on the one side and the Old World monkeys on the other. This on the following grounds.

The commonly received view that the lower caniniform tooth of recent Lemuridæ is not a 'canine' but a premolar, because it is not placed in front but behind the upper canine, dates from Geoffroy Saint-Hilaire. Objections have been raised from time to time, e.g. by Moseley and Ray Lankester,[3] and about the same time by Dönitz.[4] The latter pointed out that the tooth in question is not situated in the diastema between the upper canine and the upper anterior premolar, but acts with its cusp against the *inner* side of the upper canine. Similar remarks have been of late made by Von Lorenz.[5] A. Grandidier, on his side, believes that the presence in young Indrisinæ of a *canine de lait*, which is not replaced, settles the question once for all in favour of Geoffroy Saint-Hilaire's view.[6] However, this tooth of Indrisinæ being the evident homologue of the outer of the three incisiform teeth of other Lemuridæ, or rather of its deciduous predecessor, it proves nothing more or less than does this supposed 'lower canine' of other members of the family.

[1] Proc. Zool. Soc. London, 1899, p. 988. *Protoindris globiceps*, Lorenz (Denkschr. Akad. Wiss. Wien., lxx, 1900, p. 11, pl. iii, fig. 2), is based on a photograph from Mr. Sikora representing the reduced side view of the type of *Nesopithecus australis*.

[2] It is possible that my *Globilemur Flacourti* from the neighbourhood of Nossi-Vé on the south-west coast may prove to be specifically identical with *Bradylemur Bastardi*, G. Grand. (Bull. Mus. d'hist. nat. Paris, 1900, No. 5, p. 215), from Ambolisatra.

[3] Journ. Anat. & Physiol., iii, 1868, pp. 73–80 (1869).

[4] "Über die Eckzähne der Lemuriden": Sitzungsber. Ges. Naturf. Freunde, Berlin, 15th December, 1868, p. 32.

[5] Op. cit., p. 7.

[6] "Histoire physique, naturelle, et politique de Madagascar," Mammifères, i. p. 32, footnote 3 (1876).

The lower caniniform tooth of Mammalia is generally anterior to the upper caniniform; if, however, for some reason or other the upper premolar series should become lengthened, or the lower premolar series shortened, the position of the lower 'canine' may be altered. Bateson has described and figured an instance of the first kind. A skull of *Ateles marginatus* in the British Museum (No. 1.214*b*, collected by Bates) exhibits the unusual number of four premolars on either side of the upper jaw. "As a consequence the lower canines bite on and *partly behind* the upper canines."[1] The skull is before me: on the right side the lower canine, in fact, acts on the inner side of the upper canine; on the left side its position is almost normal.

The Cercopithecidæ, and in general all the monkeys with only two premolars, are evidently derived from older forms with three premolars. As often happens, the loss of the lower premolar may have preceded in time that of the upper jaw, so that we may imagine a transitional stage in which there were three premolars above and two below. In that case the lower canine might slide slightly backwards, and would in that case act on the inner side of the upper canine; this is precisely the condition of things in *Nesopithecus* and also in the majority of recent Lemuridæ. When finally one of the three upper premolars comes to be lost, the lower 'canine' might come again to occupy its original position in front of the upper, as is the case in all Old World monkeys.

There are, therefore, as good reasons for the assumption that the caniniform lower tooth of *Nesopithecus* and of most of the Lemuridæ is the homologue of the lower 'canine' of Old World monkeys, as for the generally received view. *Nesopithecus* has approached nearer than most of the Lemuridæ to the monkeys by retaining only two lower incisors. For, of course, as a consequence of the hypothesis propounded here, the six incisiform lower teeth of the majority of Lemuridæ would have to be considered as the homologues of the six lower incisors of the majority of Placentalia. This constitutes, for the present, its weak point, because most of the Tertiary Lemuridæ are supposed to have—and *Adapis* certainly has—only four lower incisors.

It is obvious that the position of *Nesopithecus* in the system cannot be discussed without reference to the relations between lemurs and monkeys generally. The general question being too large for discussion here, I must limit myself to the following remarks.

A. Milne-Edwards and A. Grandidier have, contrary to Mivart, considered the Lemuroidea as forming a distinct order. Although in the "Histoire de Madagascar," up to the present day, the description of the Indrisinæ alone has been published, this was believed to fully settle the question at issue. The Indrisinæ being, as far as brain development is concerned, the highest of recent lemurs, and thus approaching, more than the rest, the Anthropoidea, the conclusions as to their relationship with the latter, derived from the comparison

[1] W. Bateson: "Materials for the Study of Variation, etc.," 1894, pp. 206, 207, fig. 38.

of their other characters, seemed *a fortiori* to apply to all the other lemurs.

The careful and detailed comparisons between Indrisinæ and Anthropoidea[1] show in fact a great amount of difference between both in all the organs. But it would be an error to infer from this, without closer examination, that the same holds good with regard to all the Lemurids. In osteological characters, *Lepidolemur* and, to a somewhat lesser extent, *Chirogale*, range with the Indrisinæ; but the genera *Lemur* and *Hapalolemur*, to limit myself to Malagasy Lemuridæ, tell quite another tale. Take, for instance, the humerus. In most of the features of this bone, which have been pointed out as characteristic of the monkeys in opposition to the Indrisinæ, *Lemur* and *Hapalolemur* range on the side of the former, and this applies with greater force still to the humerus of *Nesopithecus*. The same holds good, more or less, for most parts of the skeleton, but I have purposely quoted the humerus as an example, because it is one of the few bones known of the Tertiary *Adapis*. Filhol describes it in *Adapis* as approaching closely to the '*Makis*,' having in view, I suppose, first of all the genus *Lemur*. At any rate the description and the figures of the *Adapis* humerus agree very nearly with the same bone of *Lemur* and *Hapalolemur*.

Part of the Lemuridæ therefore come in their skeleton closer to the monkeys than is generally believed,[2] and *Nesopithecus* goes a step farther in the same direction. In the latter we may distinguish four sets of characters.

1. Primitive characters which *Nesopithecus* shares with *Adapis* and with part at least of the Lemuridæ generally; e.g., cerebellum not overlapped; large bulla tympanica, tympanic ring free; orbits not closed behind by a bony septum; entepicondylar foramen of the humerus. These two last characters might with almost equal reason find a place under 2.

2. Characters which *Nesopithecus* has in common with the less specialized lemurs and with monkeys as well, and which nevertheless are comparatively primitive, for I submit that in a certain number of characters the monkeys are less specialized than numbers of lemurs; e.g., more or less vertical insertions of lower incisors, many features of the appendicular skeleton.

3. Simian characters, absent in the Lemuridæ, and which *Nesopithecus* shares exclusively with the monkeys, and some of them more particularly with the Cercopithecidæ; e.g., voluminous brain, with the arrangement of the convolutions approaching those of monkeys; steep facial profile of the skull; orbits directed straight

[1] "Histoire physique, naturelle, et politique de Madagascar," Mammifères, i (1876).

[2] "If, in accordance with the traditional views of zoologists, the Lemurs are still considered to be members of this order [i.e. Primates], they must form a sub-order apart from all the others, with which they have really very little in common except the opposable hallux of the hind foot, a character also met with in the Opossums, and which is therefore of very secondary importance."—Flower & Lydekker: "An Introduction to the Study of Mammals, living and extinct," 1891, p. 680.

forward; position of the lachrymal foramen inside the orbit (at least in one species, viz. *N. Roberti*); conformation of the internal pair of upper incisors; number of lower incisors; limb-bones as a whole in several features intermediate between monkeys and lemurs (entepicondylus of humerus strongly developed and directed backwards, etc.).

4. Characters which, being proper to *Nesopithecus*, mark its specialization; e.g., preponderance of ante-molars over the true molars, especially in the upper jaw; blade-shaped premolars; beginning of lophodonty in the true molars, the latter character being apparently more pronounced in some species than in others.

The first three sets of characters united are precisely such as must have been possessed by the immediate ancestors of the Cercopithecidæ. It is therefore difficult to imagine that the simian characters of *Nesopithecus* do not indicate any nearer relationship to the Cercopithecidæ, but that they have been independently developed in the former as a sort of simian mimicry.

The position thus taken up by the writer will have to be expressed in classification by giving up the two separate suborders of Primates, thus going one step farther than Mivart. *Nesopithecus*, with *Hadropithecus* (see below), appear to form a side-branch of the evolving line from lemurs to monkeys, branching off close below the Cercopithecidæ.

IV. HADROPITHECUS.

A further interesting addition to our knowledge of extinct Malagasy Primates is *Hadropithecus stenognathus*, Lorenz.[1] I understand from Dr. v. Lorenz that he now holds this genus to be closely related to *Nesopithecus*, a view with which I fully agree. The imperfect mandible upon which the genus is based shows the number of teeth to be the same as in *Nesopithecus*, viz., on each side six cheek-teeth, of which the three posterior are undoubtedly true molars, and two incisors inserted in a still more erect position than in the latter genus; in fact, they are well-nigh vertical. Of the cheek-teeth, the true molars preponderate in horizontal extension over the ante-molars, the opposite being the case in *Nesopithecus*.

In their pattern the true molars are not very different from those of the last-named genus, the difference appearing to be mainly the result of a more hypselodont character in the teeth of *Hadropithecus*. The posterior premolar of the latter is almost molariform, and the ante-molars as a whole are not blade-shaped, a character which gives quite a peculiar appearance to the dentition of *Nesopithecus*, recalling to mind the Plagiaulacidæ, as well as *Thylacoleo* and *Potorous* (*Hypsiprymnus*).

[1] "Uber einige Reste ausgestorbener Primaten von Madagaskar": loc. cit., pp. 2–8, pl. i, figs. 1–7.

IV.—Pleistocene Shells from the Raised Beach Deposits of the Red Sea.

By R. Bullen Newton, F.G.S., of the British Museum (Natural History).

(PLATES XX–XXII.)[1]

An interesting collection of shells, numbering more than fifteen hundred specimens, obtained by the officers of the Geological Survey of Egypt from the raised beach deposits of the Red Sea, has recently been examined by the writer at the request of Captain Lyons, R.E., the Director-General of the Survey.

With the exception of certain specimens collected by Dr. Hume from the western shore of the Gulf of Akaba, this important collection was acquired by Mr. Thomas Barron, F.G.S., from various localities situated on the western side of the Red Sea and the Gulf of Suez during the survey of that region in the years 1897–1898.

The majority of the shells belong to modern species and are well preserved, many of them retaining their original colour-markings and other characteristic features. The species exhibit the true Red Sea or Indo-Pacific facies, with a very slight commingling of Mediterranean forms, a fact which confirms the work of most previous observers, who recognize marked differences in the two faunas. A few of the specimens are quite unknown in present seas, whilst others date their origin from Miocene times, but as all are accompanied by undoubted modern species they must be admitted as their contemporaries in time. Among such may be mentioned *Alectryonia Virleti*, *Chlamys latissima*, *Chlamys Reissi*, *Pecten Vasseli*, *Lithophaga Avitensis*, *Cassis lævigata*, etc. This association of modern and extinct forms has already been observed by Professor Mayer-Eymar, Dr. Theodore Fuchs, and others in deposits of similar age near Cairo (Wadi Mellaha, etc.) and to the north of Suez (Bitter Lakes, etc.).

The marine portion of the terrace beds surrounding the Bitter Lakes resembles the raised beaches of the Red Sea in possessing a fauna of Indo-Pacific character, whereas the Cairo deposits contain an assemblage of species bearing a large percentage of Mediterranean or Atlantic forms: facts which indicate that in former times the Mediterranean extended further southwards and the Red Sea further northwards than now obtains.

In dealing with the age of these deposits it seems apparent that they should be regarded as Pleistocene on account of the large number of recent species they contain, and the comparative scarcity of extinct forms. This is in agreement with the views of most authors, who, although under different designations, acknowledge the same horizon, as, for instance, "Saharian" of Mayer-Eymar; "Recente Ablagerungen (Pseudo-Sarmatischen Ablagerungen)" of Fuchs; and "Jüngere Meeresbildungen" of Fraas. It should be mentioned, however, that Fraas only uses his term in connection

[1] These plates will appear with Part II in the December number.

with the Red Sea beach deposits, recognizing the Wadi Mellaha beds as of Miocene age, whilst Neumayr and Beyrich both regard them as Pliocene.

Some importance may be attached to the identification of *Pecten Vasseli*, a species originally described by Fuchs from the terrace formation of the Bitter Lakes, and which is doubtless the same shell referred to by Fraas under the name of *Pecten radula*, var. *subfossilis*, found in the beach deposits near Kosseir. Examples of this species, with its peculiar dichotomizing ribs and minute striated sculpture, are represented from the following localities in this collection: (*a*) Raised beach, Northern Wadi Gueh, Camp 6, 240 feet above sea; (*b*) raised beach north of Kosseir; (*c*) Upper Coral terrace (*Pecten*-bed) between Nebk and Sherm, South-East Sinai. At (*c*) *Pecten Vasseli* is associated with *Chlamys latissima*; at (*a*) with a fragment of *Chlamys opercularis*; and at (*b*) with modern Red Sea forms, *Codakia exasperata*, etc., and some extinct ones, such as *Lithophaga Lyellanus*. In its typical locality this shell is found with *Circe pectinata* and other familiar Red Sea species (see Fischer *post* "Literature"), although not known in the living state.

Among the more abundant shells of modern species in this collection, and which occur repeatedly at various localities, are: *Conus nussatella*, *Natica melanostoma*, *Strombus fasciatus*, *Turbo radiatus*, *Anadara antiquata* and *radiata*, *Chama nivalis*, *Circe pectinata*, *Codakia exasperata*, etc.

List of the Pleistocene Mollusca from the Raised Beach Deposits of the Red Sea, collected by Mr. Thomas Barron, F.G.S.

The identification of the following species has been carried out after careful comparison with the finely arranged series of modern shells in the Zoological Department of the British Museum. To Mr. Edgar Smith, the Assistant Keeper of that section of the Museum, the writer records his indebtedness for much help, especially with regard to some of the more difficult determinations that have arisen during the progress of this work. The classification of the families is that adopted at the British Museum, and originally suggested by Pelseneer in his "Introduction à l'étude des Mollusques" (Ann. Soc. Roy. Malac. Belgique, 1894, vol. xxvii, pp. 31–243).

The following explanation of bracketed names, etc., quoted under "Distribution," should be noted:—(B.M.) = British Museum (Recent Shell Department); (Barron) = a small collection of unnumbered specimens from Ras Gharib and Jebel Zeit, sent separately by Mr. Barron in August, 1898; (Tryon, Issel, etc.) = authorities for distribution of the species, *vide* "Literature" appended.

Class GASTEROPODA.

Family PATELLIDÆ.

Helcioniscus variabilis, Krauss.

Patella variabilis, Krauss: Die Südafrikanischen Mollusken, 1848, p. 35, pl. iii, fig. 12.

Distribution.—Natal (Tryon); Red Sea (B.M.). Coll. Geol. Surv. Egypt: 50 foot beach deposit at Gemsah (No. 2,043, Box No. 63*j*).

Family HALIOTIDÆ.

Haliotis cruenta, Reeve.

Haliotis cruenta, Reeve: Conchologia Iconica, vol. iii (1846), pl. xv, fig. 56.

Distribution.—Gulf of Suez and New Zealand (B.M.). Coll. Geol. Surv. Egypt: Ras Gharib (Barron); raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,058–2,098, Box No. 18*j*).

Family FISSURELLIDÆ.

Capiluna[1] Ruppelli, G. B. Sowerby.

Fissurella Ruppelli, G. B. Sowerby: Proc. Zool. Soc. London, 1834, pt. ii, p. 128; Conchological Illustrations, 1841, pl. lxxviii, fig. 65, and pl. lxxx, fig. 75.

Distribution.—Near Suez and beach deposits of Red Sea (Issel); Red Sea to Cape of Good Hope (Tryon); Aden, Red Sea, Mauritius, East Africa, Mergui (E. A. Smith). Coll. Geol. Surv. Egypt: Ras Gharib (Barron); raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,058–2,098, Box No. 18*j*); beach against old island west of Camp 51, south of Gharib lighthouse (Nos. 2,021–2,030, Box No. 57*j*).

Capiluna Ruppelli, var. **Barroni**, var. nov. (Pl. XXII, Figs. 1–4.)

The above varietal designation is applied to a number of forms which are nearly circular in outline, besides being more conical and elevated than the typical species. Sculpture characters, however, are identical; the numerous raised beaded ribs and riblets exhibiting the usual beautiful structure of this shell. The oblong perforation is also normal, and shows a slight enlargement at the posterior end. The basal margin is denticulated and laterally excavated. Size variable. Dimensions of largest specimen: height, 15 mm.; length and width, 18 mm.

This variety is represented by about a dozen specimens which were found associated with the true *C. Ruppelli*. It is to be seen in an unnamed condition in the Recent shell section of the British Museum, labelled as from the Red Sea, although the specimens have all the appearance of coming from the beach deposits of that area. Probably the form is extinct.

Distribution.—Coll. Geol. Surv. Egypt: Ras Gharib (Barron); raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,058–2,098, Box No. 18*j*).

Emarginula incisura, A. Adams.

Emarginula incisura, A. Adams: Proc. Zool. Soc. London, 1851, p. 84.

Distribution.—Apparently unknown. Coll. Geol. Surv. Egypt: Ras Gharib (Barron); raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,058–2,098, Box No. 18*j*).

[1] *Capiluna*, Gray, 1857 = *Glyphis*, Carpenter, 1856, *non* Agassiz, 1843; *vide* Harris & Burrows, Paris Basin Eocene Mollusca (Geol. Assoc.), 1891, p. 111.

Scutum unguis, Linnæus.

Patella unguis, Linnæus: Systema Naturæ, 10th ed. (1758), p. 783 (= *Parmaphorus granulatus*, Blainville, *vide* Issel).

Distribution.—Red Sea to Cape of Good Hope, Australia, Philippines, etc. (Tryon); Gulf of Suez, south of Réunion, and Red Sea deposits (Issel). Coll. Geol. Surv. Egypt: Ras Gharib (Barron); raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,098–2,105, Box No. 20*j*).

Family TROCHIDÆ.

Trochus (Cardinalia) virgatus, Gmelin.

Trochus virgatus, Gmelin: Systema Naturæ, 13th ed. (1790), p. 3,580.

Distribution.—Beach deposits on western borders of Red Sea (Gray & Frembley); Red Sea and Indian Ocean (Tryon). Coll. Geol. Surv. Egypt: Ras Gharib (Barron); raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,058–2,098, Box No. 18*j*).

Trochus (Infundibulops) erythræus, Brocchi.

Trochus erythræus, Brocchi: Catalog. una ser. Conchiglie Africana, etc., 1819–1823 (*fide* Tryon).

Distribution.—Beach deposits of Red Sea and in the Gulfs of Akaba and Suez (Issel); Red Sea (Tryon); Aden, Red Sea, Gulf of Suez (E. A. Smith). Coll. Geol. Surv. Egypt: Jebel Zeit (Barron).

Trochus (Lamprostoma) maculatus, Linnæus.

Trochus maculatus, Linnæus: Systema Naturæ, 10th ed. (1758), p. 756.

Distribution.—Beach deposits of the Red Sea (Gray & Frembley and Issel); recent forms from the Red Sea (Issel); Indian Ocean to the Philippines (Tryon). Coll. Geol. Surv. Egypt: Jebel Zeit (Barron); raised beach 80 feet above sea at Camp 6, north of Wadi Gueh, west of Kosseir (Nos. 1,649 and 1,650, Box No. 78*j*).

Clanculus Pharaonius, Linnæus. (Pl. XX, Figs. 4, 5.)

Trochus Pharaonius, Linnæus: Systema Naturæ, 10th ed. (1758), p. 757.

Distribution.—Beach deposits of the western borders of Red Sea (Gray & Frembley); Red Sea, Gulfs of Akaba and Suez (Issel); Red Sea (Tryon); Red Sea, Aden, Gulfs of Suez and Akaba (E. A. Smith). Coll. Geol. Surv. Egypt: Ras Gharib and Jebel Zeit (Barron).

Priotrochus obscurus, Wood.

Trochus obscurus, W. Wood: Index Testaceologicus, 1828, Suppl. pl. v, fig. 26.

Distribution.—Indian Ocean (Fischer); South Africa (B.M.). Coll. Geol. Surv. Egypt: raised beach east of Jebel Esh (Nos. 2,172–2,190, Box No. 64*j*).

Family TURBINIDÆ.

Turbo radiatus, Gmelin. (Pl. XX, Fig. 1.)

Turbo radiatus, Gmelin: Systema Naturæ, 13th ed. (1790), vol. i, pt. 6, p. 3,594 (= *Chemnitzianus*, Reeve).

Distribution.—Red Sea, Madagascar, and Philippines (Tryon); Red Sea, Persian Gulf, and Madagascar (E. A. Smith). Coll. Geol. Surv. Egypt: Ras Gharib (Barron); raised beach 80 feet above sea

at Camp 6, north of Wadi Gueh, west of Kosseir (Nos. 1,655–1,657, Box No. 81*j*); beach east of Gharib (Nos. 2,227–2,254, Box No. 17*j*); raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,058–2,098, Box No. 18*j*; Nos. 2,090–2,105, Box No. 20*j*); raised beach, Camp 6, Wadi Gueh (No. 1,594, Box No. 28*k*; No. 1,587, Box No. 49*k*; Nos. 1,559 and 1,561, Box No. 60*k*; Nos. 1,574, etc., Box No. 62*k*).

Family NERITIDÆ.

Nerita albicilla, Linnæus.

Nerita albicilla, Linnæus: Systema Naturæ, 10th ed. (1758), p. 778.

According to Tryon this species includes *sanguinolenta*, Menke; *marmorata*, Reeve; and *crassilabrum*, E. A. Smith.

Distribution.—Beach deposits of Red Sea (Issel); Red Sea to Philippines (Tryon); Aden, Red Sea, Indian and Pacific Oceans (E. A. Smith). Coll. Geol. Surv. Egypt: beach south of Gharib (Nos. 2,227–2,254, Box No. 17*j*); beach against old island west of Camp 51, south of Gharib lighthouse (Nos. 2,021–2,030, Box No. 57*j*); raised beach 80 feet above sea, Camp 6, Wadi Gueh (No. 1,569, Box No. 31*k*; No. 1,612, Box No. 58*k*); raised beach, Camp 6, Wadi Gueh (Nos. 1,574, etc., Box No. 62*k*).

Family HIPPONYCIDÆ.

Hipponyx barbatus, G. B. Sowerby.

Hipponyx barbatus, G. B. Sowerby: Proc. Zool. Soc. London, 1835, p. 5.

Distribution.—Mazatlan, Galapagos Islands, Polynesia, Japan, Cape of Good Hope (Tryon); Society Islands (B.M.). Coll. Geol. Surv. Egypt: Ras Gharib (Barron); raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,058–2,098, Box No. 18*j*).

Family CYPRÆIDÆ.

Cypræa annulus, Linnæus.

Cypræa annulus, Linnæus: Systema Naturæ, 10th ed. (1758), p. 723.

Distribution.—Gulf of Akaba, Mediterranean and beach deposits of Red Sea (Issel); Indian and Pacific Oceans, and fossil in Southern Europe (Tryon); Aden (E. A. Smith). Coll. Geol. Surv. Egypt: raised beach, Wadi Gueh, Camp 6 (No. 1,568, Box No. 29*k*); raised beach east of Jebel Esh (Nos. 2,172–2190, Box No. 64*j*).

Cypræa Arabica, Linnæus.

Cypræa Arabica, Linnæus: Systema Naturæ, 10th ed. (1758), p. 718.

Distribution.—Beach deposits of Red Sea (Gray & Frembley, Issel); Gulf of Akaba and Ras Benass (Issel); Indian and Pacific Oceans (Tryon); Aden (E. A. Smith). Coll. Geol. Surv. Egypt: beach east of Gharib (Nos. 2,227–2,254, Box No. 17*j*).

Cypræa caurica, Linnæus.

Cypræa caurica, Linnæus: Systema Naturæ, 10th ed. (1758), p. 723.

Distribution.—Beach deposits of Red Sea (Gray & Frembley); Gulf of Akaba (Issel); Indian and Pacific Oceans (Tryon); Aden (E. A. Smith). Coll. Geol. Surv. Egypt: east of Gharib (Nos. 2,227–2,254, Box No. 17*j*).

Cypræa cylindrica, Born.

Cypræa cylindrica, Born: Testacea Mus. Cæsarei Vindobonensis, 1780, pl. viii, fig. 10.

DISTRIBUTION.—Amboina, etc. (B.M.); Ceylon, Australia, New Caledonia (Tryon). Coll. Geol. Surv. Egypt: raised beach, Camp 6, Wadi Gueh (Nos. 1,591 and 1,567, Box No. 30*k*).

Cypræa erosa, Linnæus.

Cypræa erosa, Linnæus: Systema Naturæ, 10th ed. (1758), p. 723.

DISTRIBUTION.—Beach deposits of Red Sea (Gray & Frembley, Issel); Gulf of Akaba (Issel); Indian and Pacific Oceans (Tryon); Aden (E. A. Smith). Coll. Geol. Surv. Egypt: raised beach 80 feet above sea, Camp 6, north of Wadi Gueh, west of Kosseir (Nos. 1,649 and 1,650, Box No. 78*j*; Nos. 1,591 and 1,567, Box No. 30*k*); 50 foot beach, Gemsah (No. 2,038, Box No. 62*j*).

Cypræa fimbriata, Gmelin.

Cypræa fimbriata, Gmelin: Systema Naturæ, 13th ed. (1790), vol. i, pt. 6, p. 3,420.

DISTRIBUTION. — Indian Ocean to Australia (Tryon); Aden (E. A. Smith). Coll. Geol. Surv. Egypt: raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,058–2,098, Box No. 18*j*).

Cypræa isabella, Linnæus.

Cypræa isabella, Linnæus: Systema Naturæ, 10th ed. (1758), p. 722.

DISTRIBUTION.—Beach deposits and recent forms in Red Sea (Issel); Indian and Pacific Oceans (Tryon); Aden (E. A. Smith). Coll. Geol. Surv. Egypt: Ras Gharib (Barron); raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,058–2,098, Box No. 18*j*); raised beach, Camp 6, Wadi Gueh (Nos. 1,591 and 1,567, Box No. 30*k*).

Cypræa turdus, Lamarck.

Cypræa turdus, Lamarck: Hist. Nat. Anim. sans Vert., vol. vii (1822), p. 392.

DISTRIBUTION.—Beach deposits on the western borders of the Red Sea (Gray & Frembley); Gulf of Akaba and Indian Ocean (Issel); Aden (E. A. Smith); Persian Gulf (Tryon). Coll. Geol. Surv. Egypt: beach east of Gharib (Nos. 2,227–2,254, Box No. 17*j*); raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,058–2,098, Box No. 18*j*); 50 foot beach at Gemsah (Nos. 2,031–2,057, Box No. 58*j*).

Cypræa vitellus, Linnæus.

Cypræa vitellus, Linnæus: Systema Naturæ, 10th ed. (1758), p. 721.

DISTRIBUTION.—Aden (E. A. Smith); beach deposits, western shores of Red Sea (Gray & Frembley); Indian Ocean, Australia, New Caledonia (Tryon). Coll. Geol. Surv. Egypt: raised beach, Camp 6, Wadi Gueh (Nos. 1,574, etc., Box No. 62*k*).

Family NATICIDÆ.

Natica (Mammilla) melanostoma, Gmelin.

Nerita melanostoma, Gmelin: Systema Naturæ, 13th ed. (1790), vol. i, pt. 6, p. 3,674.

DISTRIBUTION. — Beach deposits of Red Sea (Fraas, Gray & Frembley); Red Sea and Indian Ocean (Issel); Mauritius,

Madagascar, East Indies, Polynesia (Tryon); Aden, Red Sea, Indian Ocean, and parts of the Pacific (E. A. Smith). Coll. Geol. Surv. Egypt: Jebel Zeit (Barron); raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,058–2,098, Box No. 18*j*); recent beach south of Gharib lighthouse (Nos. 2,198–2,216, Box No. 53*j*); 50 foot beach at Gemsah (Nos. 2,031–2,057, Box No. 58*j*).

Family CERITHIIDÆ.

Cerithium cæruleum, G. B. Sowerby.

Cerithium cæruleum, G. B. Sowerby: Thesaurus Conchyliorum, vol. ii (1855), p. 866, pl. clxxix, figs. 61, 62.

Distribution.—Red Sea (Issel); Red Sea and Indian Ocean (Tryon); Aden, Red Sea, Indian Ocean, China, Tonga Islands (E. A. Smith). Coll. Geol. Surv. Egypt: Jebel Zeit (Barron); recent beach south of Gharib lighthouse (Nos. 2,198–2,216, Box No. 53*j*); raised beach, Camp 6, Wadi Gueh (Nos. 1,559 and 1,561, Box No. 60*k*; Nos. 1,574, etc., Box No. 62*k*).

Cerithium columna, G. B. Sowerby.

Cerithium columna, G. B. Sowerby: Genera of Shells, 1834, No. 42, fig. 7.

Distribution. — Mauritius, Philippines to Central Polynesia (Tryon); Aden, Red Sea, Indian Ocean, Philippines, etc. (E. A. Smith). Coll. Geol. Surv. Egypt: Ras Gharib (Barron).

Cerithium erythræonense, Lamarck.

Cerithium erythræonense, Lamarck: Hist. Nat. Anim. sans Vert., vol. vii (1822), p. 70 (=*tuberosum*, Reeve, and *omissum*, Bayle).

Distribution.—Desert of Attaka, Suez, Gulf of Akaba, Red Sea, Madagascar (Issel); Red Sea (Tryon). Coll. Geol. Surv. Egypt: Ras Gharib (Barron); beach east of Gharib (Nos. 2,227–2,254, Box No. 17*j*); raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,090–2,105, Box No. 20*j*); recent beach south of Gharib lighthouse (No. 2,204, Box No. 24*j*); raised beach, Camp 6, Wadi Gueh (Nos. 1,559 and 1,561, Box No. 60*k*).

Cerithium Ruppelli, Philippi.

Cerithium Ruppelli, Philippi: Zeitsch. Malakozoologie, 1848, p. 22.

Distribution.—Gulf of Suez (Issel); Red Sea (Tryon); Red Sea, Aden, Seychelles (E. A. Smith). Coll. Geol. Surv. Egypt: Recent beach between Jebel Mellaha and Jebel Zeit (Nos. 2,162–2,167, Box No. 21*j*); 50 foot beach at Gemsah (Nos. 2,031–2,057, Box No. 58*j*); beach against old island west of Camp 51, south of Gharib lighthouse (Nos. 2,021–2,030, Box No. 57*j*).

Vertagus asperum, Linnæus (var.).

Murex asper, Linnæus: Systema Naturæ, 10th ed. (1758), p. 756.

Distribution.—I. of France (B.M.); beach deposits of the Red Sea (Issel). Coll. Geol. Surv. Egypt: raised beach, Camp 6, Wadi Gueh (Nos. 1,574, etc., Box No. 62*k*).

Vertagus fasciatus, Bruguière.

Cerithium fasciatum, Bruguière: Encyclop. Méthodique, 1792, vol. i (vers.), p. 474.

Distribution.—Red Sea, Gulf of Akaba, Indian Ocean, Philippines (Issel, Tryon). Coll. Geol. Surv. Egypt: Jebel Zeit (Barron);

50 foot beach at Gemsah (Nos. 2,031–2,057, Box No. 58); raised beach east of Jebel Esh (Nos. 2,172–2,190, Box No. 64*j*).

Vertagus Kochi, Philippi.

Cerithium Kochi, Philippi: Zeitsch. Malakozoologie, 1848, p. 21.

Distribution.—East coast of Africa (Tryon); Aden, Red Sea, Indian Ocean, Japan (E. A. Smith). Coll. Geol. Surv. Egypt: Jebel Zeit (Barron); raised beach east of Jebel Esh (Nos. 2,172–2,190, Box No. 64*j*).

Vertagus recurvus, G. B. Sowerby.

Cerithium recurvum, G. B. Sowerby: Thesaurus Conchyliorum, vol. ii (1855), p. 854, pl. clxxvi, figs. 16–18.

Distribution.—Red Sea (Tryon). Coll. Geol. Surv. Egypt: beach east of Gharib (Nos. 2,227–2,254, Box No. 17*j*); raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,058–2098, Box No. 18*j*); 50 foot beach at Gemsah (Nos. 2,031–2,057, Box No. 58*j*); raised beach east of Jebel Esh (Nos. 2,172–2,190, Box No. 64*j*).

Pirenella mammillata, Risso.

Cerithium mammillatum, Risso: Hist. Nat. Europe Méridionale, vol. iv (1826), p. 158.

Tryon includes in this species *conica* of Blainville, *cinerascentis* of Pallas, *Cailliaudi* of Pot. & Mich.

Distribution.—Mediterranean and Red Sea (Tryon); Alexandria, Suez, Egypt (B.M.). Coll. Geol. Surv. Egypt: Recent beach south of Gharib lighthouse (No. 2,217, Box No. 52*j*; Nos. 2,198–2,216, Box No. 53*j*); beach against old island west of Camp 51, south of Gharib lighthouse (Nos. 2,021–2,030, Box No. 57*j*).

Family MODULIDÆ.

Modulus tectum, Gmelin.

Trochus tectum, Gmelin: Systema Naturæ, 13th ed. (1790), vol. i, pt. 6, p. 3,569.

Distribution.—Red Sea, Mauritius, Indian Ocean, Sandwich and Viti Islands (Tryon). Coll. Geol. Surv. Egypt: east of Gharib (Nos. 2,227–2,254, Box No. 17*j*).

Family VERMETIDÆ.

Vermetus, sp. indet.

Distribution.—Coll. Geol. Surv. Egypt: raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,058–2,098, Box No. 18*j*).

Family TURRITELLIDÆ.

Turritella trisulcata, Lamarck.

Turritella trisulcata, Lamarck: Hist. Nat. Anim. sans Vert., vol. vii (1822), p. 58.

Distribution.—Gulf of Suez and in the beach deposits of the Red Sea (Issel); Red Sea (Tryon). Coll. Geol. Surv. Egypt: Gemsah, 50 foot beach (Nos. 2,031–2,057, Box No. 58*j*); east of Jebel Esh (Nos. 2,172–2,190, Box No. 64*j*).

Family STROMBIDÆ.

Strombus fasciatus, Born. (Pl. XX, Fig. 3.)

Strombus fasciatus, Born: Testacea Mus. Cæsarei Vindobonensis, 1780, p. 278 (= *lineatus*, Lam.).

Distribution.—Red Sea, Gulf of Akaba, and beach deposits of the Red Sea (Issel); Red Sea to Philippines (Tryon). Coll. Geol. Surv. Egypt: Recent beach between Jebel Mellaha and Jebel Zeit (No. 2,159, Box No. 10*j*, and Nos. 2,162–2,167, Box No. 21*j*); east of Gharib (Nos. 2,227–2,254, Box No. 17*j*); south of Gharib lighthouse (Nos. 2,198–2,216, Box No. 53*j*); Gemsah, 50 foot beach (Nos. 2,031–2,057, Box No. 58*j*); east of Jebel Esh (Nos. 2,172–2,190, Box No. 64*j*); camp north of Wadi Gueh, west of Kosseir, 80 feet above sea (Nos. 1,655–1,657, Box No. 81*j*); Ras Gharib and Jebel Zeit (Barron); raised beach 80 feet above sea, Camp 6, Wadi Gueh (No. 1,571, Box No. 38*k*); raised beach, Camp 6, Wadi Gueh (No. 1,572, Box No. 52*k*, and Nos. 1,574, etc., Box No. 62*k*).

Strombus floridus, Lamarck.

Strombus floridus, Lamarck: Hist. Nat. Anim. sans Vert., vol. vii (1822), p. 211.

Distribution.—Beach deposits near Kosseir (Fraas); Kosseir and Akaba Gulf (Issel); Zanzibar, Japan, Australia to Viti Islands (Tryon); Red Sea, Indian Ocean, Philippines (E. A. Smith). Coll. Geol. Surv. Egypt: raised beach 80 feet above sea, Camp 6, Wadi Gueh (No. 1,871, Box No. 38*k*); raised beach, Camp 6, Wadi Gueh (Nos. 1,574, etc., Box No. 62*k*).

Strombus fusiformis, G. B. Sowerby.

Strombus fusiformis, G. B. Sowerby: Thesaurus Conchyliorum, vol. i (1847), pl. ix, figs. 91, 92.

Distribution.—Gulf of Akaba and beach deposits of the Red Sea (Issel); Aden, Red Sea, Indian Ocean, North Australia (E. A. Smith). Coll. Geol. Surv. Egypt: Gemsah, 50 foot beach (Nos. 2,031–2,057, Box No. 58*j*); Ras Gharib and Jebel Zeit (Barron).

Strombus tricornis, Lamarck.

Strombus tricornis, Lamarck: Hist. Nat. Anim. sans Vert., vol. vii (1822), p. 201.

Distribution.—Red Sea, Kosseir, East Indies, etc. (Issel); Red Sea, Bourbon, Seychelles, Philippines (E. A. Smith). Coll. Geol. Surv. Egypt: raised beach 80 feet above sea at Wadi Gueh, Camp 5 (No. 1,607, Box No. 84*j*). A large cast in sandstone of most probably this species from raised beach north of Kosseir (No. 2,137, Box No. 30*j*); another cast which may have belonged to this species or to *S. Bonelli*, Brongniart, from raised beach 380 feet above sea near Camp 7, Wadi Shigeleh (No. 1,613, Box No. 65*k*).

Canarium dentatum, Linnæus, var. erythrynum, Chemnitz.

Strombus dentatus, Linnæus: Systema Naturæ, 10th ed. (1758), p. 745.
Strombus erythrynum, Chemnitz: Conchylien-Cabinet, vol. xi (1795), p. 146, pl. cxcv, figs. 1,874, 1,875.

Distribution.—Red Sea to Australia (Tryon); Red Sea, Indian Ocean, etc. (E. A. Smith). Coll. Geol. Surv. Egypt: east of Gharib (Nos. 2,227–2,254, Box No. 17*j*); raised beach 20 feet

above sea at Gharib lighthouse (Nos. 2,058–2098, Box No. 18*j*); Ras Gharib (Barron); 50 foot beach, Gemsah (No. 1,626, Box No. 65*k*).

Canarium gibberulum, Linnæus. (Pl. XX, Fig. 2.)

Strombus gibberulus, Linnæus: Systema Naturæ, 10th ed. (1758), p. 744.

Distribution. — Beach deposits near Kosseir (Fraas, Gray & Frembley); Red Sea (Issel); Red Sea, Zanzibar to Philippines (Tryon); Aden, Red Sea, Indian Ocean, etc. (E. A. Smith). Coll. Geol. Surv. Egypt: raised beach 80 feet above sea, Camp 6, Wadi Gueh (Nos. 1,655–1,657, Box No. 81*j*, and No. 1,571, Box No. 38*k*); raised beach, Camp 6, Wadi Gueh (No. 1,598, Box No. 59*k*, and No. 1,574, etc., Box No. 62*k*); Jebel Zeit (Barron).

Pterocera millepeda, Linnæus.

Strombus millepeda, Linnæus: Systema Naturæ, 10th ed. (1758), p. 743.

Distribution.—Red Sea and Indian Ocean (Issel); Indian Ocean to Philippines (Tryon). Coll. Geol. Surv. Egypt: 50 foot beach at Gemsah, south of Jebel Zeit (No. 1,819, Box No. 54*j*).

Family LAMPUSIIDÆ (= TRITONIDÆ).

Lampusia pilearis, Lamarck.

Triton pileare, Lamarck: Hist. Nat. Anim. sans Vert., vol. vii (1822), p. 182.

Distribution. — Beach deposits of the Red Sea (Gray & Frembley, Issel); Red Sea to Philippines (Tryon); Aden, Red Sea, Indian and Pacific Oceans, etc. (E. A. Smith). Coll. Geol. Surv. Egypt: 50 foot beach at Gemsah, south of Jebel Zeit (Nos. 2,031–2,057, Box No. 58*j*).

Apollon tuberculatum, Broderip.

Ranella tuberculata, Broderip: Proc. Zool. Soc. London, 1832, p. 179.

Distribution.—Red Sea, Indian Ocean, etc. (Tryon). Coll. Geol. Surv. Egypt: Recent beach between Jebel Mellaha and Jebel Zeit (Nos. 2,162–2,167, Box No. 21*j*); raised beach, Wadi Gueh, Camp 6 (No. 1,587, Box No. 49*k*).

Family CASSIDIDÆ.

Cassis (Casmaria) nodulosa, Gmelin.

Buccinum nodulosum, Gmelin: Systema Naturæ, 13th ed. (1790), vol. i, pt. 6, p. 3,479.

(Vars. = torquata, Reeve, *vide* Tryon.)

Distribution. — Red Sea (Issel); Port Jackson, Australia (Tryon); Aden, Red Sea, Mozambique, Andaman Islands (E. A. Smith). Coll. Geol. Surv. Egypt: raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,090–2,105, Box No. 20*j*).

Cassis (Semicassis) lævigata? Defrance.

Cassis lævigata, Defrance: Dict. Sci. Nat. (Paris), 1817, p. 210 (= *saburon*, Hörnes, *non* Lamarck).

This species is represented by casts only, hence its identification is a little doubtful.

Distribution.—Miocene: Vienna Basin. Pliocene: Italian Basin. Coll. Geol. Surv. Egypt: raised beach east of Jebel Esh (Nos.

2,172–2,190, Box No. 64*j*); raised beach 380 feet above sea near Camp 7, Wadi Shigeleh (No. 1,642, Box No. 42*k*).

Family DOLIIDÆ.

Dolium variegatum, Lamarck.

Dolium variegatum, Lamarck: Hist. Nat. Anim. sans Vert., vol. vii (1822), p. 261.

DISTRIBUTION.—Gulfs of Suez and Akaba (Issel); North Australia (Tryon). Coll. Geol. Surv. Egypt: raised beach 2 or 3 feet above sea-level at Gemsah Bay, near Jebel Zeit, collected by Dr. Hume.

Dolium (Perdix) perdix, Linnæus.

Buccinum perdix, Linnæus: Systema Naturæ, 10th ed. (1758), p. 734.

DISTRIBUTION.—Beach deposits on the western shores of the Red Sea (Gray & Frembley); Indian Ocean to Polynesia (Tryon); West Indies, West Africa, Indian and Pacific Oceans (E. A. Smith). Coll. Geol. Surv. Egypt: beach near Dahab, Sinai (No. 4,325, Box No. 48*l*).

Family FASCIOLARIIDÆ.

Fusus polygonoides, Lamarck.

Fusus polygonoides, Lamarck: Hist. Nat. Anim. sans Vert., vol. vii (1822), p. 129.

DISTRIBUTION.—Red Sea (Issel); Eastern seas (B.M.); East Indies (Tryon). Coll. Geol. Surv. Egypt: Ras Gharib (Barron); Recent beach south of Gharib lighthouse (No. 2,203, Box No. 23*j*); beach against old island west of Camp 51, south of Gharib lighthouse (Nos. 2,021–2,030, Box No. 57*j*); raised beach 380 feet above sea near Camp 7, Wadi Shigeleh (No. 1,642, Box No. 42*k*).

Latirus turritus, Gmelin.

Voluta turrita, Gmelin: Systema Naturæ, 13th ed. (1790), vol. i, pt. 6, p. 3,456.

DISTRIBUTION.—Red Sea, Philippines, Australia, Polynesia (Tryon). Coll. Geol. Surv. Egypt: raised beach, Camp 6, Wadi Gueh (No. 1,597, Box No. 55*k*).

Family TURBINELLIDÆ.

Melongena (Volema) paradisiaca, Reeve.

Pyrula paradisiaca, Reeve: Conchologia Iconica, vol. iv (1847), fig. 17 (= *Pyrula nodosa*, Lamarck).

DISTRIBUTION.—Desert of Attaka and Red Sea (Issel); Red Sea and Ceylon (Tryon); Aden, Red Sea, Mozambique, Natal, Ceylon, Bourbon (E. A. Smith). Coll. Geol. Surv. Egypt: Recent beach between Jebel Mellaha and Jebel Zeit (No. 2,159, Box No. 10*j*); 50 foot beach at Gemsah (Nos. 2,031–2,057, Box No. 58*j*).

Vasum cornigerum, Lamarck. (Pl. XX, Fig. 12.)

Turbinella cornigera, Lamarck: Hist. Nat. Anim. sans Vert., vol. vii (1822), p. 105.

DISTRIBUTION.—Beach deposits near Kosseir (Fraas); Red Sea and Indian Ocean (Issel); Philippines (Tryon). Coll. Geol. Surv. Egypt: raised beach 80 feet above sea, Camp 6, north of Wadi Gueh, west of Kosseir (Nos. 1,653, 1,654, Box No. 80*j*); raised beach, Camp 6, Wadi Gueh (No. 1,595, Box No. 32*k*).

Family MITRIDÆ.

Mitra Bovei, Kiener.

Mitra Bovei, Kiener: Spécies Général Icon. Coq. Vivantes, monograph *Mitra*, p. 9, pl. ii, fig. 5.

DISTRIBUTION.—Red Sea (Issel, Tryon); beach deposits of the Red Sea (Issel). Coll. Geol. Surv. Egypt: raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,058–2,098, Box No. 18*j*).

Mitra (Chrysame) rubiginea, A. Adams.

Mitra rubiginea, A. Adams: Proc. Zool. Soc. London, 1854, p. 134.

DISTRIBUTION.—Mauritius and New Caledonia (Tryon). Coll. Geol. Surv. Egypt: Recent beach between Jebel Mellaha and Jebel Zeit (Nos. 2,162–2,167, Box No. 21*j*).

Mitra (Chrysame) Ruppelli, Reeve.

Mitra Ruppelli, Reeve: Conchologia Iconica, vol. ii (1844), pl. xxiii, fig. 179.

DISTRIBUTION.—Beach deposits of the Red Sea (Issel); Gulf of Akaba (Issel); Red Sea (Tryon). Coll. Geol. Surv. Egypt: raised beach 20 feet above sea, Gharib lighthouse (Nos. 2,058–2,098, Box No. 18*j*).

Family BUCCINIDÆ.

Pisania ignea, Gmelin.

Buccinum igneum, Gmelin: Systema Naturæ, 13th ed. (1790), vol. i, pt. 6, p. 3,494.

DISTRIBUTION.—Red Sea to Philippines (Tryon). Coll. Geol. Surv. Egypt: raised beach 20 feet above sea, Gharib lighthouse (Nos. 2,058–2,098, Box No. 18*j*).

Columbella fasciata, G. B. Sowerby.

Columbella fasciata, G. B. Sowerby: Cat. Shells Coll. Tankerville, Appendix, 1829, p. 25.

DISTRIBUTION.—Java (Tryon). Coll. Geol. Surv. Egypt: 50 foot beach, Gemsah (Nos. 2,031–2,057, Box No. 58*j*); raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,058–2,098, Box No. 18*j*).

Nassa pulla, Linnæus.

Buccinum pullus, Linnæus: Systema Naturæ, 10th ed. (1758), p. 737.

DISTRIBUTION.—Red Sea (Issel); Red Sea to Philippines (Tryon); Aden, Red Sea, Java, Philippines (E. A. Smith). Coll. Geol. Surv. Egypt: east of Gharib (Nos. 2,227–2,254, Box No. 17*j*); raised beach, Camp 6, Wadi Gueh (No. 1,587, Box No. 49*k*).

Nassa (Alectryon) glans, Linnæus.

Buccinum glans, Linnæus: Systema Naturæ, 10th ed. (1758), p. 737.

DISTRIBUTION.—Japan, Philippines, Australia (Tryon). Coll. Geol. Surv. Egypt: Ras Gharib (Barron).

Family MURICIDÆ.

Murex ternispina, Lamarck.

Murex ternispina, Lamarck: Hist. Nat. Anim. sans Vert., vol. vii (1822), p. 158.

DISTRIBUTION. — Red Sea to Philippines (Issel, Tryon); Red Sea, Indian Ocean, China, Philippines, Japan (E. A. Smith). Coll.

Geol. Surv. Egypt: beach against old island west of Camp 51, south of Gharib lighthouse (Nos. 2,021–2,030, Box No. 57*j*).

Chicoreus anguliferus, Lamarck. (Pl. XX, Fig. 11.)

Murex anguliferus, Lamarck: Hist. Nat. Anim. sans Vert., vol. vii (1822), p. 171.

Distribution.—Gulf of Akaba and beach deposits of the Red Sea (Issel); Red Sea and Indian Ocean (Tryon); Aden, Red Sea, Persian Gulf, Indian Ocean, Seychelles, Ceylon (E. A. Smith). Coll. Geol. Surv. Egypt: Recent beach south of Gharib lighthouse (No. 2,201, Box No. 22*j*).

Sistrum cancellatum, Quoy & Gaimard.

Murex cancellata, Quoy & Gaimard: Dumont d'Urville's "Voyage l'Astrolabe," vol. ii (1832), p. 563, pl. xxxvii, figs. 15, 16.

Distribution.—Philippines to Sandwich Islands (Tryon). Coll. Geol. Surv. Egypt: beach east of Gharib (Nos. 2,227–2,254, Box No. 17*j*).

Sistrum elatum, Blainville.

Purpura elata, Blainville: Nouv. Ann. Mus. (Paris), vol. i (1832), p. 207, pl. xi, fig. 1.

Distribution.—Philippines, etc. (Tryon); Red Sea, New Holland, Philippines (E. A. Smith). Coll. Geol. Surv. Egypt: Ras Gharib (Barron); beach east of Gharib (Nos. 2,227–2254, Box No. 17*j*); raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,058–2,098, Box No. 18*j*); recent beach between Jebel Mellaha and Jebel Zeit (Nos. 2,162–2,167, Box No. 21*j*); 50 foot beach, Gemsah (Nos. 2,031–2,057, Box No. 58*j*).

Family CORALLIOPHILIDÆ.

Magilus antiquus, De Montfort.

Magilus antiquus, De Montfort: Conchyliologie Systématique, vol. ii (1810), p. 42.

Piercing a coral, *Cœloria Arabica*.

Distribution.—Red Sea (Issel, Tryon). Coll. Geol. Surv. Egypt: Jebel Zeit (No. 780, Box No. 49*j*); beach east of Gharib (Nos. 2,227–2,254, Box No. 17*j*).

Family OLIVIDÆ.

Oliva (Carmione) inflata, Lamarck.

Oliva inflata, Lamarck: Hist. Nat. Anim. sans Vert., vol. vii (1822), p. 429.

Distribution.—Beach deposits of the Red Sea (Issel); Red Sea, East Africa, Madagascar, Seychelles (Tryon); Red Sea, Persian Gulf, Madagascar, Zanzibar, Mauritius, Ceylon, etc. (E. A. Smith). Coll. Geol. Surv. Egypt: Recent beach between Jebel Mellaha and Jebel Zeit (Nos. 2,162–2,167, Box No. 21*j*); shore and raised beach, Ras Mohamed, Sinai (No. 3,530, Box No. 45*l*).

Oliva (Ispidula) ispidula, Linnæus.

Voluta ispidula, Linnæus: Systema Naturæ, 10th ed. (1758), p. 730.

Distribution.—Indian Ocean, Philippines (Tryon). Coll. Geol. Surv. Egypt: raised beach east of Jebel Esh (No. 2,172–2,190, Box No. 64*j*).

Ancilla cinnamomea, Lamarck.

Ancillaria cinnamomea, Lamarck: Hist. Nat. Anim. sans Vert., vol. vii (1822), p. 413 (= *crassa* and *albisuleata*, G. B. Sowerby, *vide* Tryon).

Distribution.—Red Sea (Issel); Red Sea, Persian Gulf, Zanzibar (Tryon); Aden (E. A. Smith). Coll. Geol. Surv. Egypt: raised beach 20 feet above sea at Gharib lighthouse (Nos. 2,090–2,105, Box No. 20*j*).

Ancilla (Sparella) acuminata, G. B. Sowerby.

Ancillaria acuminata, G. B. Sowerby: Thesaurus Conchyliorum, vol. iii (1866), pl. ccxiv, figs. 66, 67.

Distribution.—Red Sea, Aden, Indian Ocean (E. A. Smith); Red Sea, Zanzibar (Tryon). Coll. Geol. Surv. Egypt: raised beach, Camp 6, Wadi Gueh (Nos. 1,574, etc., Box No. 62*k*).

Family PLEUROTOMIDÆ.

Pleurotoma Garnonsi, Reeve. (Pl. XX, Fig. 10.)

Pleurotoma Garnonsi, Reeve: Conchologia Iconica, vol. i (1843), pl. i, fig. 4.

Distribution.—Red Sea to Java (Tryon). Coll. Geol. Surv. Egypt: Gemsah, 50 foot beach (Nos. 2,031–2,057, Box No. 58*j*).

Family TEREBRIDÆ.

Terebra Babylonia, Lamarck.

Terebra Babylonia, Lamarck: Hist. Nat. Anim. sans Vert., vol. vii (1822), p. 287.

Distribution.—China, Viti Islands (Tryon). Coll. Geol. Surv. Egypt: Jebel Zeit (Barron).

Terebra cancellata, var. **columellaris**, Hinds.

Terebra cancellata, Quoy & Gaimard: Dumont d'Urville's "Voyage l'Astrolabe," vol. ii (1832), p. 471, pl. xxxvi, figs. 27, 28.

Terebra columellaris, Hinds: Proc. Zool. Soc. London, 1843, p. 151.

Distribution. — Moluccas, Philippines, Viti Islands, Sandwich Islands (Tryon). Coll. Geol. Surv. Egypt: Jebel Zeit (Barron).

Terebra consobrina, Deshayes.

Terebra consobrina, Deshayes: Proc. Zool. Soc. London, 1859, p. 305.

Distribution.—Red Sea (Issel, Tryon). Coll. Geol. Surv. Egypt: Recent beach between Jebel Mellaha and Jebel Zeit (Nos. 2,162–2,167, Box No. 21*j*); Gemsah, 50 foot beach (Nos. 2,031–2,057, Box No. 58*j*); Sinai (Box No. 3,516*l*).

Terebra crenifera, Deshayes.

Terebra crenifera, Deshayes: Proc. Zool. Soc. London, 1859, p. 298 (= *cingulifera*, Lamarck, *vide* Tryon).

Distribution. — Philippines, New Ireland, Viti Islands, China (Tryon); China Sea (B.M.). Coll. Geol. Surv. Egypt: 50 foot beach at Gemsah (Nos. 2,031–2057, Box No. 58*j*).

Terebra duplicata, Linnæus. (Pl. XX, Fig. 6.)

Buccinum duplicatum, Linnæus: Systema Naturæ, 10th ed. (1758), p. 742.

Distribution.—Beach deposits of the Red Sea (Gray & Frembley, Issel); Gulf of Akaba, Zanzibar, China, Madagascar, Moluccas (Issel, Tryon). Coll. Geol. Surv. Egypt: east of Gharib (Nos. 2,227–2,254, Box No. 17*j*); Gharib lighthouse, 20 feet above sea (Nos. 2,090–2,105, Box No. 20*j*); Gemsah, 50 foot beach (Nos. 2,031–2,057, Box No. 58*j*); Jebel Zeit (Barron).

Terebra (Subula) maculata, Linnæus. (Pl. XX, Fig. 7.)

Buccinum maculatum, Linnæus: Systema Naturæ, 10th ed. (1758), p. 741.

Distribution.—Gulf of Suez, Gulf of Akaba, Society Islands, Moluccas, Australia (Issel, Tryon). Coll. Geol. Surv. Egypt: lower coral reef north of Ras Mohamed or Ghazlandi Bay (No. 3,502, Box No. 41 *l*).

(*To be concluded in our next Number.*)

V.—Note on the Horizon and Locality of Sowerby's Type-Specimen of *Nautilus truncatus*.

By G. C. Crick, F.G.S., of the British Museum (Natural History).

Nautilus truncatus was described and figured by J. Sowerby in the "Mineral Conchology," vol. ii, p. 49, pl. cxxiii, April, 1816, his description and remarks being as follows:—

"*Spec. char.* Thick, flatted, plain, umbilicate; back flat, mouth elongated, four-angled: siphuncle nearest to the inner margin of the septum.

"*Syn.* Lister, 1048.

"Thickness rather less than half the diameter; the sides are rather conical and even. Mouth above half the diameter of the shell, long, narrowest towards the back, siphuncle oval. Septa very numerous, not recurved towards the umbilicus.

"A fine specimen of this species is figured by Lister, measuring ten inches in the longest diameter; no doubt, when perfect it is sometimes much larger: mine is eight inches, I figure a part of it, as sufficient; the remainder is a broken continuation of it. I have never seen the last chamber. This is composed of a mixture of dark lias limestone and pyrites, found at Keynsham, S.E. of Bristol. It is also said to be found in the blue lias of Bath, etc. Lister does not say where his specimen was found; his figure shows about three whorls, mine did not expose them; possibly when the shell is removed the whorls may be uncovered. Mine has fragments of the shell of considerable thickness about it, indicating that it was smooth when perfect."

Sowerby's type-specimen, of which only a portion was figured, is now in the British Museum collection (register No. 44,117*a*). In his remarks, Sowerby says he had never seen the last chamber, by which statement he must mean that he had not seen the *whole* of the last chamber, for half of the unfigured portion of the specimen is an internal cast of a portion of the body-chamber, the rest being composed of internal casts of the last four loculi[1] or cameræ. The umbilicus was evidently closed.[2]

In his "Supplemental Index" (p. 251) to vol. ii of Sowerby's "Mineral Conchology," Farey gives for this species the localities "Bath W, and Keynsham."

[1] Usually called 'air-chambers.'

[2] The specimen figured by Lister evidently had an open umbilicus, and, judging by the figure, it was, I believe, from the Calcareous grit, and is referable to J. de C. Sowerby's *Nautilus hexagonus* (Min. Conch., vol. vi, 1826, p. 55, pl. dxxix, fig. 2).

On account of the horizon and locality that Sowerby ascribed to this specimen, the species has been usually regarded as of Lower Liassic age, but the matrix differs entirely from that of the Ammonites from Keynsham that are in the British Museum collection, and Mr. Etheridge, who is well acquainted with the rocks at Keynsham, after examining the specimen, tells me that it is certainly not from that locality. Moreover, if the specimen had been found at Keynsham it seemed to me most probable that there would be examples of the species in the Bristol Museum, but Mr. Bolton, the Curator of that Museum, having at my request looked over all the Liassic Cephalopoda there, tells me that he cannot find an example of *Nautilus truncatus*.

During an examination of some Jurassic Nautili in the British Museum, Mr. S. S. Buckman, some time since, suggested to me that the specimen was not from the Lias, but possibly from "the Fullers' Earth in the neighbourhood of Midford, containing *Rhynchonella* like *varians*." With reference to this suggestion I can only state that there is no record of a *Nautilus* from the Fullers' Earth in H. B. Woodward's Memoir on the Lower Oolitic rocks of England and Wales (Mem. Geol. Survey), and so far as I am aware no example has yet been recorded from that deposit.

Fortunately there are remains of other fossils in the infilling of the body-chamber of the specimen; these include *Rhynchonella*, *Myacites*, *Astarte*, *Isocardia*, *Ostrea*, a Gasteropod (probably *Eulima*), and a portion of a fish-tooth which Dr. Smith Woodward has identified as *Strophodus*.

The matrix of the specimen, the mode of preservation, and the associated fossils led me to think that the fossil was of Cornbrash age. I therefore carefully examined the Cornbrash Nautili in the British Museum collection. With one exception these came from a small pit,[1] which was temporarily opened some years ago in the neighbourhood of Bedford, where they occurred with such characteristic Cornbrash fossils as '*Ammonites*' *discus*, *Waldheimia obovata*, *Nucleolites clunicularis*, *Holectypus depressus*, *Pygurus Michelini*, etc., and on comparison I found them to agree in all respects so perfectly with Sowerby's type-specimen that there cannot be the slightest doubt as to the identity of the species. The largest example of this species in the collection is about $13\frac{1}{2}$ inches in diameter.

My conclusions, then, with regard to Sowerby's type are (i) that it is not of Liassic age, (ii) that it did not come from Keynsham, and (iii) that it came from the Cornbrash, but from what locality I do not venture to suggest.

Mr. E. T. Newton, of the Geological Survey, and Prof. J. F. Blake, who has quite recently made a special study of the Cornbrash, have examined the fossil, and I am pleased to be allowed to state that both support me in my conclusions as to the age of the specimen.

[1] This pit was known to the writer as the "Midland Railway Pit"; it was on the south-western side of the town, on the small piece of ground on the western side of, and adjoining, the main line of the Midland Railway, and between the Kempston Road and the river. I believe the stone was excavated for building a wall at the northern end of the Ampthill Tunnel.

NOTICES OF MEMOIRS.

British Association for the Advancement of Science, Bradford, 1900.

Address to the Zoological Section. By Ramsay H. Traquair, M.D., LL.D., F.R.S., President of the Section. (Slightly abridged.)

(*Concluded from the October Number, p.* 470.)[1]

COMING now to say a word regarding the Elasmobranchii, it is plain from the fin-spines found in Upper Silurian rocks that they are of very ancient origin, and that if we only knew them properly they would have a wonderful tale of evolution to tell. But their internal skeleton is from its nature not calculated for preservation, and for the most part we only know those creatures from scattered teeth, fin-spines, and shagreen, specimens showing either external configuration or internal structure being rare, especially in Palæozoic strata. But from what we do know, there is no doubt that the ancient sharks were less specialized than those of the present day, and that the recent Notidanids still preserve peculiarities which were common in the Selachii of past ages.

If we ask whether the fossil sharks throw any light on the disputed origin of the paired limbs, whether from the specialization of right and left lateral folds, or whether that type of limb called 'archipterygium' by Gegenbaur, consisting of a central jointed axis with pre- and post-axial radial cartilage attached, was the original form, I fear we get no very definite answer from Elasmobranch palæontology. The paired fins of the Upper Devonian shark, *Cladoselache*, as described by Bashford Dean, Smith Woodward, and others, seem to favour the lateral fold theory, and Cope pointed to the right and left series of small intermediate spines which in some Lower Devonian Acanthodei (*Parexus* and *Climatius*) extend between the pectorals and ventrals as evidence of a former continuous lateral fin. So also, if I am right in looking on the lateral flaps of the Cœlolepidæ as fins, the evidence of these ancient Ostracodermi would be in the same direction.

But, on the other hand, we have the remarkable group of Pleuracanthidæ, extending from the Lower Permian back to the Upper Devonian, in which the paired fins are represented by an 'archipterygium' which in the pectoral at least is biserial.

From this biserial 'archipterygium' in the Pleuracanthidæ, Professor A. Fritsch, ten years ago,[2] derived the tribasal arrangement of modern sharks, much according to the Gegenbaurian method, effecting, however, a compromise with the lateral fold theory by assuming that the Pleuracanth form originated from one, consisting of simple parallel rods, like that described in *Cladoselache*.

[1] The reader is requested to note the following errata in the part of this Address published in our last number, namely, at p. 465, line 30, for "Under" read "Unless," and in line 31 delete the semicolon after "pectorals."

[2] "Fauna der Gaskohle und der Kalksteine der Permformation Böhmens," vol. iii, pt. 1 (Prague, 1890), pp. 44–45.

In my description of the pectoral fin of the Carboniferous *Cladodus Neilsoni*,[1] I have shown that the cartilaginous structures apparently present an uniserial archipterygium intermediate between the arrangement in *Pleuracanthus* and that in the modern sharks, but I felt compelled to acknowledge that the specimen might also be interpreted in exactly the opposite way, namely, as an example of a transition from the 'ptychopterygium' of *Cladoselache* to the Pleuracanth and Dipnoan limb. And so, in fact, this fin of *Cladodus* is claimed in support of their views by both parties in the dispute.

When we add that Semon emphatically denies that there is any proof for considering that the pectoral fin of *Cladoselache* is primitive in its type,[2] and that Campbell Brown, in his recent paper on the Mesozoic genus *Hybodus*,[3] supports Gegenbaur's theory, it will be seen that Elasmobranch palæontology has not as yet uttered any very clear or decided voice on the question as to whether the so-called archipterygium is the primary form of paired fin in the fish, or only a secondary modification. We shall now inquire if we can obtain any more light on the subject from the Crossopterygii and Dipnoi.

The Crossopterygii are a group of Teleostomous fishes characterized externally by their jugular plates and lobate paired fins, and represented in the present day only by the African genera *Polypterus* and *Calamoichthys*, which together form the peculiar family Polypteridæ. The Crossopterygii appear suddenly in the middle of the Devonian period, their previous ancestry being unknown to us.

Four families[4] are known to us in Palæozoic times—the Osteolepidæ, Rhizodontidæ, Holoptychiidæ, and Cœlacanthidæ—but it is only with the first three that we have at present to deal. The Osteolepidæ and Rhizodontidæ, which appear together in Middle and die out together in Upper Palæozoic times, resemble each other very closely. In both we have the paired fins, more especially the pectoral, obtusely or subacutely lobate; there are two separate dorsal fins, one anal, and the caudal, which is usually heterocercal, though in some genera it is more or less diphycercal. In both the teeth are conical and have the same complex structure, the dentine being towards the base thrown into vertical labyrinthic folds, exactly as in the Stegocephalian Labyrinthodonts, and this along with the lung-like development of the double air-bladder in the recent Polypteridæ has given rise to the view that from these forms the Stegocephalia have originated. The nasal openings must have been on the under surface of the snout, as in the Dipnoi.

Of these two so closely allied families we must conclude that the Osteolepidæ are the more primitive, as in them the scales are acutely rhombic and usually covered with a thick layer of ganoine, while

[1] Trans. Geol. Soc. Glasgow, vol. xi, pt. 1 (1897), pp. 41–50.

[2] "Die Entwickelung der paarigen Flossen des *Ceratodus Forsteri*"; Jena, 1898.

[3] "Ueber das Genus *Hybodus* und seine systematische Stellung": Palæontographica, vol. xlvi (1900).

[4] *Five*, if we include the singular and still imperfectly known Tarrasiidæ of the Lower Carboniferous.

in the Rhizodontidæ they are rounded, deeply imbricating, and normally devoid of the ganoine layer, which, however, occasionally recurs on the scales of *Rhizodopsis* and the fin-rays of *Gyroptychius*.

What, then, of the structure of the paired fins? Fortunately, in the Rhizodont genera *Tristichopterus* and *Eusthenopteron* the internal skeleton of the lobe was ossified, and what we see clearly exhibited in the pectoral of some specimens is striking enough. We have a basal piece attached to the shoulder-girdle and followed by a median axis of four ossicles placed end to end. The first of these shows on its postaxial margin a strong projecting process, while to its preaxial side, close to its distal extremity, a small radial piece is obliquely articulated, and a similar one is joined also to the second and third segments of the axis. The arrangement in the ventral fin is essentially similar.

In fact, we have in the Rhizodontidæ a short uniserial 'archipterygium,' and the question is, Has this been formed by the shortening up and degeneration of an originally elongated and biserial one, or on the other hand, do we find here a condition in which the stage last referred to has not yet been attained? This question is inseparable from the next, whether the Rhizodonts or the Holoptychians form the most advanced type.

The Holoptychiidæ resemble the Rhizodontidæ extremely closely in their external head-bones, in their rounded, deeply imbricating scales, and in the form and arrangement of their median fins. But the teeth show a more complex and specialized structure than those of the Rhizodontidæ; the simple vertical vascular tubes formed by the repeated folding of the dentine in that family being connected by lateral branches around which the dentine tubules are grouped in such a way as to give rise in transverse sections to a radiating arborescent appearance; hence the term 'dendrodont.' In this respect, then, the Holoptychiidæ show an advance on the Rhizodontidæ—what then of the paired fins? While the ventral remains subacutely lobate, as in the previous family, the pectoral has now assumed an elongated *acutely lobate* shape, with the fin-rays arranged along the two sides of a central scaly axis exactly as in the Dipnoi; and though the internal skeleton has not yet been seen, yet, judging by analogy, we cannot escape the belief that it was in the form of a complete biserial 'archipterygium.'

What, then, is the condition of affairs in the oldest known Dipnoan?

The oldest member of this group with whose configuration we are acquainted is *Dipterus*, which likewise appears in the middle of the Devonian period simultaneously with the Osteolepidæ, Rhizodontidæ, and Holoptychiidæ. In external form it closely resembles a Holoptychian, having a heterocercal caudal fin, two similarly placed dorsals, one anal, and circular imbricating scales, which, however, have the exposed part covered with smooth ganoine. But now we have the ventrals as well as the pectorals acutely lobate in shape, and presumably archipterygial in structure; the top of the head is covered with many small plates, there is no longer

a dentigerous maxilla, the skull is autostylic, and the palatopterygoids and the mandibular splenial are like those of *Ceratodus* and bear each a tooth-plate with radiating ridges.

Now, comparing *Dipterus* with the recent *Ceratodus* and *Protopterus*, the first conclusion we are likely to draw is, that the older Dipnoan is a very specialized form, that its heterocercal tail and separate dorsals and anal are due to specialization from the continuous diphycercal dorso-ano-caudal arrangement in the recent forms, that the Holoptychiidæ were developed from it by shortening up of the ventral archipterygium, as well as by the changes in cranial structure, and that the Rhizodontidæ and Osteolepidæ are a still more specialized series in which the pectoral archipterygium has also shared the fate of the ventral in becoming shortened up and uniserial.

Five years ago, however, M. Dollo proposed a new view to the effect that the process of evolution had gone exactly in the opposite direction;[1] and after long consideration of the subject I find it difficult to escape from the conclusion that this view is more in accordance with the facts of the case, though, as we shall see, it also has its own difficulties.

I have already indicated above that we are, on account of the more specialized structure of the teeth, justified in considering the Holoptychians, with their acutely lobate pectorals, a newer type than the Rhizodonts, even though they did not survive so long in geological time. What, then, of the question of autostyly?

We do not know the suspensorium of *Holoptychius*, but that of the Rhizodontidæ was certainly hyostylic, as in the recent *Polypterus*. Now, as there can be no doubt that the autostylic condition of skull is a specialization on the hyostylic form, as seen also in the Chimæroids and in the Amphibia, to suppose that the hyostylic Crossopterygii were evolved from the autostylic Dipnoi is, to say the least, highly improbable; in my own opinion, as well as in that of M. Dollo, it will not stand. And if we assume a genetic connection between the two groups it is in accordance with all analogy to look on the Dipnoi as the children and not as the parents of the Crossopterygii.

M. Dollo adopts the opinion of Messrs. Balfour and Parker that the apparently primitive diphycercal form of tail of the recent Dipnoi is secondary, and caused by the abortion of the termination of the vertebral axis as in various 'Teleostei,' so that no argument can be based on the supposition that it represents the original 'protocercal' or preheterocercal stage. Very likely that is so, but it is not of so much importance for the present inquiry, as both in the Osteolepidæ and Rhizodontidæ we find among otherwise closely allied genera some which are heterocercal, others more or less diphycercal. *Diplopterus*, for example, differs from *Thursius* only by its diphycercal tail, and in like manner among the Rhizodontidæ *Tristichopterus* is heterocercal, *Eusthenopteron* is nearly diphycercal, and

[1] "Sur la Phylogénie des Dipneustes": Bull. Soc. belge géol. paléont. hydr., vol. ix (1895).

there can be no doubt that in spite of this their caudal fins are perfectly homologous structures.

But of special interest is the question of the primitive or non-primitive nature of the continuity of the median fins in the recent Dipnoi. Like others I was inclined to believe it primitive, and that the broken-up condition of these fins in *Dipterus* was a subsequent specialization, and in fact gave the series *Phaneropleuron, Scaumenacia, Dipterus macropterus,* and *D. Valenciennesii* as illustrating this process of differentiation. This view, of course, draws on the imperfection of the geological record in assuming the existence of ancient pre-Dipterian Dipnoi with continuous median fins, which have never yet been discovered. But Dollo, using the very same series of forms, showed good reason for reading it in exactly the opposite direction.

The series is as follows :—

1. *Dipterus Valenciennesii,* Sedgw. & Murch., from the Orcadian Old Red, and the oldest Dipnoan with whose shape we are acquainted, has two dorsal fins with *short* bases, a heterocercal caudal, and one short-based anal.

2. *Dipterus macropterus,* Traq., from a somewhat higher horizon in the Orcadian series, has the base of the second dorsal much *extended,* the other fins remaining as before.

3. In *Scaumenacia curta* (Whiteaves), from the Upper Devonian of Canada, the first dorsal has advanced considerably towards the head, and its base has now become elongated, while the second has become still larger and more extended, though still distinct from the caudal posteriorly.

4. In *Phaneropleuron Andersoni,* Huxley, from the Upper Old Red of Fifeshire, the two dorsal fins are now fused with each other and with the caudal, forming a long continuous fin along the dorsal margin, while the tail has become nearly diphycercal, with elongation of the base of the lower division of the fin. But the anal still remains separate, narrow, and short-based.

5. In the Carboniferous *Uronemus lobatus,* Ag., the anal is now also absorbed in the lower division of the caudal, forming likewise on the hæmal aspect a continuous median fin behind the ventrals. There is also a last and feeble remnant of a tendency to an upward direction of the extremity of the vertebral axis.

6. In the recent *Ceratodus Forsteri,* Krefft, the tail is diphycercal (secondary diphycercy), the median fins are continuous, the pectorals and ventrals retain the biserial archipterygium, but the cranial roof-bones have become few.

7. In *Protopterus annectens,* Owen, the body is more eel-like, and the paired fins have lost the lanceolate leaf-like appearance which they show in *Ceratodus* and the older Dipnoi. They are like slender filaments in shape, with a fringe on one side of minute dermal rays; internally they retain the central jointed axis of the 'archipterygium,' but according to Wiedersheim the radials are gone, except it may be one pair at the very base of the filament.

8. Finally, in *Lepidosiren paradoxa,* Fitz., the paired fins are still

more reduced, having become very small and short, with only the axis remaining.

From this point of view, then, *Dipterus*, instead of being the most specialized Dipnoan, is the most archæic, and the modern *Ceratodus*, *Protopterus*, and *Lepidosiren* are degenerate forms; and instead of the Crossopterygii being the offspring of *Dipterus*-like forms, it is exactly the other way, the Dipnoi owing their origin to Holoptychiidæ, which again are a specialization on the Rhizodontidæ, though they did not survive so long as these in geological time. Consequently the *Ceratodus* limb, with its long median segmented axis and biserial arrangement of radials, is not an archipterygium in the literal sense of the word, but a derivative form traceable to the short uniserial type in the Rhizodonts. But from what form of fin *that* was derived is a question to which palæontology gives us no answer, for the progenitors of the Crossopterygii are as yet unknown to us.

Plausible and attractive as this theory undoubtedly is, and though it relieves the palæontologist from many difficulties which force themselves upon his mind if he tries to abide by the belief that the Dipnoan form of limb had a selachian origin, and was in turn handed on by them to the Crossopterygii, yet it is not without its own stumbling-blocks.

First as to the dentition, on which, however, M. Dollo does not seem to put much stress, it is impossible to derive *Dipterus directly* from the Holoptychiidæ, unless it suddenly acquired, as so many of us have to do as we grow older, a new set of teeth. The dendrodont dentition of *Holoptychius* could not in any way be transformed into the ctenodont or ceratodont one of *Dipterus*: both are highly specialized conditions, but in different directions. Semon has recently shown that the tooth-plates of the recent *Ceratodus* arise from the concrescence of numerous small simple conical teeth, at first separate from each other.[1] Now this stage in the embryo of the recent form represents to some extent the condition in the Uronemidæ of the Carboniferous and Lower Permian, which stand quite in the middle of Dollo's series.

Again, the idea of the origin of the Dipnoi from the Crossopterygii in the manner sketched above cuts off every thought of a genetic connection between the biserial archipterygium in them and in the Pleuracanthidæ, so that we should have to believe that this very peculiar type of limb arose independently in the Selachii as a parallel development. It may be asked, Why not? We may feel perfectly assured that the autostylic condition of the skull in the Holocephali arose independently of that in the Dipnoi, as did likewise a certain amount of resemblance in their dentition. But those who from embryological grounds oppose any notion of the origin of the Dipnoi from 'Ganoids' might here say, if they chose, If so, why should not also the same form of limb have been independently evolved in Crossopterygii?

Accordingly, while philosophic palæontology is much indebted to M. Dollo for his brilliant essay, and though we must agree with him

[1] "Die Zahnentwickelung des *Ceratodus Forsteri*"; Jena, 1899.

in many things, such as that the Crossopterygii were not derived *from* the Dipnoi, and that the modern representatives of the latter group are degenerate forms, yet as to the *immediate* ancestry of the Dipnoi themselves, and the diphyletic origin of the so-called archipterygium, we had best for the present keep an open mind.

In his "Catalogue of the Fossil Fishes" in the British Museum (vol. ii, 1891) Dr. Smith Woodward, following the suggestion of Newberry in 1875, classified the Coccosteans or 'Arthrodira' as an extremely specialized group of Dipnoi. At first I was much taken with that idea, but after looking more closely into the subject I began to doubt it extremely. My own opinion at present is that the Coccosteans are Teleostomi belonging to the next order, Actinopterygii; but Professor Bashford Dean, of New York, will not have them to be even 'fishes,' but places them in a distinct class of 'Arthrognatha,' which he places next to the Ostracophori (=Ostracodermi), even hinting at a possible union with them, whereby the old 'Placodermata' of McCoy would be restored. It will, therefore, be better to leave them out of consideration for the present, pending a thorough re-examination of their structure and affinities.

We come then to the great order of Actinopterygii, to which a large number of the fishes of later Palæozoic age belong, as well as the great mass of those of Mesozoic, Tertiary, and modern times. Of these we first take into consideration the oldest sub-order, namely, the Acipenseroidei or Sturgeon tribe, in which the dermal rays of the median fins are more numerous than their supporting ossicles, while the tail is, in most, completely heterocercal. The oldest family of Acipenseroids with which we are acquainted is that of the Palæoniscidæ, which, in addition to well-developed cranial and facial bones, has the body normally covered with rhombic ganoid scales furnished with peg-and-socket articulations. It endures up to the Purbeck division of the Jurassic formation, and in the Carboniferous *Cryphiolepis*, the Lower Permian *Trissolepis*, and the Jurassic *Coccolepis* we find the same degeneration of the rhombic scales into those of a circular form and imbricating arrangement, which we find repeated in other groups of 'Ganoids.'

In these Palæozoic times we notice also a side branch of the Palæoniscidæ, constituting the family Platysomidæ, in which, while the median fins acquire elongated bases, the body becomes shortened up and deep in contour. A most interesting series of forms can be set up, beginning with *Eurynotus*, which, though it has the platysomid head contour and a long-based dorsal, has only a slight deepening of the body, and still retains the palæoniscid squamation and a short-based anal fin. In *Mesolepis*, which resembles *Eurynotus* in shape, being only slightly deeper, we have now the characteristic platysomid squamation, and the base of the anal fin is considerably elongated. *Platysomus* has a still more elongated anal fin, and the body is rhombic; while in *Cheirodus* the body is still deeper in contour, with peculiar dorsal and ventral peaks, long fringing dorsal and anal fins, while the ventrals seem to have disappeared altogether. Here also, as in the allied genus *Cheirodopsis*, the separate cylindro-

conical teeth characteristic of the family are, on the palatal and splenial bones, replaced by dental plates, reminding us of those of the Dipnoi. Certainly the Platysomidæ seem to me to form a morphological series telling as strongly in favour of Descent as any other in the domain of palæontology.[1]

If we now return to the Palæoniscidæ we find that they dwindled away in numbers in the Jurassic rocks, and finally became extinct at the close of that epoch. But already in the Lias (leaving the Triassic Catopteridæ out of consideration for the present) we find that they have sent off another offshoot sufficiently distinct to be reckoned as a new and separate family, namely, the Chondrosteidæ, in which the path of degeneration, in all but the matter of size, seems to have been entered on.

In the genus *Chondrosteus*, though the palæoniscid type is clearly traceable in the cranial structure, there is marked degeneration as regards the amount of ossification, and though the suspensorium is still obliquely directed backward the toothless jaws are comparatively short, and the mouth seems now to have become tucked in under the snout as in the recent sturgeon. Then the scales have entirely disappeared from the skin except on the upper lobe of the heterocercal caudal fin, where they are still found arranged exactly as in the Palæoniscidæ.

Chondrosteus in fact conducts us to the recent Acipenseroids—the Polyodontidæ (Paddle-fishes) and Acipenseridæ (Sturgeons). So the sturgeons and paddle-fishes of the present day would seem to be the degenerate, though bulky, descendants of the once extensively developed group of Palæoniscidæ, even as the modern Dipnoi are degenerated from those of Palæozoic times.

In the Upper Permian occurs the genus *Acentrophorus*, whose fellowship with *Semionotus*, *Lepidotus*, and all the rest of the series of Mesozoic semi-heterocercal 'Ganoids' is at once obvious. If we look at the configuration of a typical Jurassic member of this series, such as *Lepidotus* or *Eugnathus*, we shall at once see that we are a stage nearer the modern osseous fish. Though the scales are bony, rhombic, and ganoid, we are struck by the 'Teleostean'-like aspect of the external bones and plates of the head, the rays of the dorsal and anal fins are fewer and correspond in their number to that of the internal supports or 'interspinous' bones, while in the caudal we see the semi-heterocercal or abbreviate-heterocercal condition.

Then, if we refer to the tail of *Lepidosteus* itself, we shall observe how few are its rays and how evident it is that we have here to do only with the lower lobe of the original palæoniscoid caudal fin. For a convincing corroboration of this we have only to look at the tail of the embryo *Lepidosteus* as described and figured by Professor A. Agassiz to see that it in reality passed through an Acipenseroid stage, and the last we see of the upper lobe of this tail is in the form of a filament which projects from the top of the original lower lobe and then disappears.

[1] R. H. Traquair, "Structure and Affinities of the Platysomidæ": Trans. Roy. Soc. Edin., vol. xxix (1879), pp. 343–391.

Again, in these Lepidosteid forms we have a repetition of the same tendency for the thick rhombic, peg-and-socket articulating scales to become rounded and imbricating, as we saw in the Crossopterygii and again in the Palæoniscidæ. To such an extent does this go that in the recent *Amia*, whose skeletal structure so clearly shows it to belong to this group, the rounded scales are so thin and flexible that after it was removed from the Clupeoid family, or Herrings, and placed among the 'Ganoids," it was considered to be the type of a distinct sub-order of 'Amioidei.'

As the Acipenseroids dwindled away after the close of the great Palæozoic era, and are now scantily represented only by the degenerate paddle-fishes and sturgeons, so the Lepidosteid series, flourishing greatly in the Trias and Jura, in their turn declined in the Cretaceous, and in the Tertiary period became about as much a thing of the past as they are now, the North American *Lepidosteus* and *Amia*, of which remains of extinct species have also been found in Eocene and Miocene rocks, only remaining. These two genera, can, however, hardly be called 'degenerate.'

But that the fishes which succeeded the Lepidosteids in populating the seas and rivers of the globe were evolved from them there can be no reasonable doubt, while it is equally clear that they branched off at an early period, as already in the Trias we find the first representatives of the order of Isospondyli, which contains our familiar Herrings, Salmonids, Elopids, Scopelids, etc. For Dr. Smith Woodward has not only definitely placed the Jurassic Leptolepidæ and Oligopleuridæ in the Isospondyli, but also the Pholidophoridæ, which appear in the Trias and extend to the Purbeck. And it is of special interest that in the Pholidophori the scales are still brilliantly ganoid, and mostly retain the peg-and-socket articulation, while in the allied Leptolepidæ, although they have become thin and circular, a layer of ganoine mostly remains.

With the Isospondyli we now get fairly among the bony fishes of modern type—Teleostei as we used to call them—to which other sub-orders are added in Cretaceous and Tertiary times, and which in the present day have assumed an overwhelming numerical preponderance over all other fishes. The prevalent form of scale among these is thin, rounded, deeply imbricating, and with the posterior margin either plain (cycloid) or serrated (ctenoid). But that these 'cycloid' and 'ctenoid' scales are modifications from the rhombic osseous 'ganoid' type we cannot doubt after what we have seen. It is indeed strange that the same tendency to the change of rhombic into circular overlapping scales should have occurred independently in more than one group.

Incompletely as I have treated the subject, it cannot but be acknowledged that the palæontology of fishes is not less emphatic in the support of Descent than that of any other division of the animal kingdom. The modern type of bony fish, though not so 'high' in many anatomical points as that of the Selachii, Crossopterygii, Dipnoi, Acipenseroidei, and Lepidosteoidei of the Palæozoic and Mesozoic eras, is more specialized in the direction of the fish proper.

REVIEWS.

A TREATISE ON ZOOLOGY. Edited by E. RAY LANKESTER. PART III: THE PORIFERA AND CŒLENTERATA. By E. A. MINCHIN, M.A., G. HERBERT FOWLER, B.A., Ph.D., and GILBERT C. BOURNE, M.A., with an Introduction by E. RAY LANKESTER. pp. vi and 368, with 227 figures in the text. (London: Adam & Charles Black, 1900.)

PROFESSOR LANKESTER is to be congratulated on the speedy appearance of another part of his "Treatise on Zoology," and it is to be devoutly hoped that the remaining eight parts will appear with even greater rapidity if the work is to be completed before the first volumes are out of date.

The present part is of special interest to students of comparative morphology, since it contains a chapter by the editor on the much vexed subject of the cœlom. Speculations concerning the origin and homologies of the variously developed body-cavities found among the Metazoa have so long been associated with Professor Lankester's name that an article giving his latest views on this subject will command careful attention from all, even although some may be of the opinion that the present state of our knowledge concerning these cavities is not sufficient to justify all his conclusions. As an argument against the too previous introduction of the cœlom as a feature of classificatory value, we may compare the use made of it in the present work with that adopted by Sedgwick in his recent textbook: the latter authority would exclude the Platyhelmia, the Nematoidea, the Nemertina, and the Rotifera from his Cœlomata, whereas Lankester includes all these in his grade Cœlomocœla, a term which he proposes to substitute for the well-known Cœlomata.

With reference to these new terms, of which there are several, we should have thought that Professor Lankester's long experience as a teacher would have shown him the futility and undesirability of overburdening a science with new words, especially when they only serve to replace terms long sanctioned by use, solely on the grounds that his new words are more expressive than the old ones. If we were once to commence to replace all the old morphological terms at present in use which, being invented by our more fanciful forefathers, are now found through our increasing knowledge to be deprived of some of their meaning, we should find ourselves lost, like the modern systematist, in a maze of words, and all solid work would be at a standstill. While we would deplore the mere substitution of terms like Cœlomocœla for Cœlomata and Enterocœla for Cœlenterata, we find no objection to the invention of terms to express fresh ideas, and it is possible that the term Phlebœdesis, as applied to the origin of the body-cavity in the Arthropoda and Mollusca, may be found a very useful one. At any rate, Professor Lankester's exposition of his theory of Phlebœdesis is very instructive.

This volume is about equally divided between the Porifera and the Cœlenterata, a division which appears to us to be somewhat unfair, for the components of the latter group differ so much more from one another than do the various classes of the Porifera, that in our opinion they should have been allotted a larger space. At the same time we should not like this to have been done at the expense of Professor Minchin's article, which appears to be a most admirable one, and one that will long serve as a valuable introduction to the study of the Porifera. This article contains a large amount of original observations and many new figures, but so great is Professor Minchin's modesty that only those who have worked at sponges will recognize the new matter. In dealing with the histology we are glad to see that Professor Minchin throws considerable doubt upon the special sense-organs and nerve-cells as described by Stewart, Sollas, and von Lendenfeld, and we could only wish that Mr. Fowler, in dealing with the so-called ganglionic cells of the last-mentioned observer in the Hydroids, had been equally bold.

The great difficulty in these composite textbooks is to mete out equal treatment to the various groups of animals dealt with, as each writer has his own ideas on the style of article required, and we are afraid that both the articles on the Hydromedusæ and the Anthozoa suffer somewhat from a comparison with that on the Porifera. Those on the Hydromedusæ and the Scyphomedusæ especially appear to be far too condensed and hardly critical enough for this ambitious work; the illustrations of these parts, too, are for the most part very antiquated.

Perhaps the part which appeals most nearly to the palæontologist will be that dealing with the Anthozoa by Mr. Bourne. Here, at any rate, no fault can be found with the age of the illustrations, almost all of which appear to have been specially drawn for the article. Unfortunately, owing to the adoption of the half-tone process, the printing of these beautiful figures has not been always successful. Mr. Bourne's article obviously suffers from delayed publication, and consequently much important work dealing with the formation and nature of the coral-skeleton has to be briefly referred to in an appendix. Mr. Bourne has done considerable work on the relation of the hard and soft parts in the corals, but we cannot help asking for his authority in his representation of the epitheca in fig. 28 as a saucer-like structure surrounding the theca but separated by a distinct interval into which a hollow reduplication of the body-wall extends.

The present volume contains six chapters, which, with the exception of chapters iv and v, are separately paginated, and the contained figures are separately numbered; each, further, is provided with an index: these indices are sometimes difficult to find, and we personally should have preferred a continuous pagination and a general index at the end of the volume.

CORRESPONDENCE.

GEOLOGICAL HYPOTHESIS.

SIR,—In the July number of your Magazine, just received, there is an article called "A Word on Geological Hypothesis," by Professor H. Macaulay Posnett.[1] After some admirable platitudes on the subject of scientific dogmatism, he proceeds to explain why he has been forced to tender this kindly advice by the following illustrations.

"Shortly after the Tarawera eruption of June, 1886, some professors of science proceeded to the Rotorua district and there held a Maori meeting. The Maoris were told that, the lines of volcanic energy having such and such directions, they need entertain no fears of the recurrence of the late disaster—'they might plant their kumeras in peace.' Hereupon an old Maori chief, with the usual sagacity of his race, rose and remarked, 'If the volcano-doctors know so much about what is to be, what a pity it was they did not come and forewarn us of the eruption.' Needless to say, the 'volcano-doctors' had no reply; and in our civilized views of volcanic forces it would be far better to own ignorance than to even hint a claim to foresight where it does not as yet exist."

Now as I am one of the 'volcano-doctors' referred to, and Professor Posnett was at the time in Auckland, 170 miles away, I suppose I know more about what took place than he does. The following is a plain statement of the facts. Professors Thomas and Douglas-Brown, of the Auckland University College, and myself were commissioned by the N.Z. Government to report upon the eruption. The Maoris, naturally, were in a great state of alarm. Many had left and quartered themselves on neighbouring tribes; and the remainder wanted to leave, but had no land to go to. Under these circumstances the Resident Magistrate at Rotorua asked us whether we could help in dissipating these fears. We consented to try. He called a meeting, and I, as senior, was deputed to make the speech. I pointed out that as the eruption had only lasted for a few hours and had been over for more than a week, it was not likely that it would recur in the near future, as time must be allowed for the subterranean forces to again accumulate. Even, I said, if a second eruption should take place it would probably not be a severe one, like the first, for an opening had been made through which the steam could now escape. I said nothing about lines of volcanic energy. The Maoris saw the common-sense of these reasons; their fears ceased, the runaways returned, and crops for the coming season were planted. I do not remember being asked why we had not forewarned the Maoris of the eruption—it sounds like a newspaper yarn—but if I was so asked, no doubt I made it clear to my audience that the two things were very different; a point which Professor Posnett appears not to see.

[1] GEOL. MAG., 1900, pp. 298–302.